

Consolidated Assessment and Listing Methodology

Surface Water Quality Assessment in Kentucky: The Integrated Report

(salient sections excerpted from the CALM)

Abbreviations, Acronyms and Definitions

ADB:	Assessment Data Base- used to manage assessment determinations and associated water body information.
AKGWA:	Assembled Kentucky Ground Water- unique identity code for springs.
ATTAINS:	Assessment and TMDL Tracking and Implementation System- EPA system for national reporting of assessed water bodies.
BMU:	Basin Management Unit- hydrological unit of associated water bodies defined for resource management.
CAH:	Cold Water Aquatic Habitat- habitats capable of supporting indigenous coldwater aquatic life or self-sustaining or reproducing trout populations year-round.
CAS #:	Chemical Abstract Number- unique numeric identification for chemicals assigned by Chemical Abstract Services.
CCR:	Consumer Confidence Report- annual compliance report for domestic drinking water finishers; compliance based on federal and state codes that set maximum contaminant levels for various pollutants.
Conventional Pollutant:	Pollutants readily treatable by municipal sewage treatment plant. These are: biological oxygen demand; fecal coliform; oil and grease; pH; and total suspended solids. These pollutants also are in the broader list of nonpriority pollutants.
CWA:	Clean Water Act- established by congress in 1972, with subsequent amendments, to restore and maintain the chemical, physical and biological integrity of the nation's water bodies.

DBI:	Diatom Bioassessment Index- multimetric index used to detect responses to pollutants by the diatom community.
DMR:	Discharge Monitoring Report- required reporting of discharged pollutants relative to limits under the NPDES (National Pollutant Discharge Elimination System) program.
DO:	Dissolved oxygen – available oxygen in the water column oxygen for aquatic organisms.
DOW:	Kentucky Division of Water – agency of the Department for Environmental Protection, Energy and Environment Cabinet.
DEP:	Kentucky Department for Environmental Protection
DFWR:	Kentucky Department of Fish & Wildlife Resources
DU:	Designated Use – appropriate, beneficial uses of the aquatic resources, e.g., streams, lakes and springs, along with water quality standards to manage these resources.
DWS:	Domestic Water Supply – water body source used to produce water for human (domestic) consumption.
EDAS:	Ecological Data Application System – database used to manage biological, physical and chemical data.
EPA:	U.S. Environmental Agency
EPT:	Ephemeroptera, Plecoptera, Trichoptera – three orders of aquatic insects that generally are indicative of good water quality.
Evaluated Data:	Examples include, data not collected in-stream such as discharge data from a permitted facility like a municipal wastewater treatment plant or observational information. Data not collected under proper SOP or environmental conditions may be evaluated, but not used alone to make a designated use assessment decision.
FSA:	U.S. Farm Services Agency
GIS:	Geographic Information System – designed to capture analyze manage and present spatial or geographical information.
GLI:	Great Lakes Initiative- agreement between EPA and Great Lakes states to a plan to restore the health of the Great Lakes.
GNIS:	Geographic Names Information System – a database containing names and location information about physical and cultural features in the USA.
Hg-guidance:	Guidance for Implementing the January 2001 methylmercury water quality criterion.

HUC:	Hydrologic Unit Code – numeric sequence used to identify a river, reach of river or area of drainage.
IR:	Integrated Report – comprises the 305(b) report of a state’s inventory of aquatic resources and assessed waters and the 303(d) list of impaired water bodies and segments.
KAR:	Kentucky Administrative Regulation – regulations that include the Commonwealth’s water quality standards.
KIBI:	Kentucky Index of Biotic Integrity – multimetric index calibrated to detect changes of the fish community to physical and chemical disturbances.
KORA:	Kentucky open records act. Act provides for the access to information that complies with the conditions of the law.
KPDES:	Kentucky Pollutant Discharge Elimination System – permitting program authorizing the discharge of pollutants to water bodies; this is the delegated National Pollutant Discharge Elimination System under the CWA Section 402.
MBI:	Macroinvertebrate Bioassessment Index – multimetric index calibrated to detect changes of the aquatic insect community to physical and chemical disturbances.
MCL:	Maximum Contaminant Level – the level of a contaminant in drinking water below which there is no expected adverse health effects.
MP:	Mile Point – used to describe an assessment unit of a stream in the Integrated Report.
Monitored Data:	Data collected in-stream or in-lake and appropriate to utilize for making designated use assessment decisions. Data used for initial designated use assessment is preferred not older than five years, but older data will be considered on an individual basis for such qualities as type of data (biological or water quality grab samples, including bacteria) that may be considered still relevant to likely current environmental conditions.
NHD:	National Hydrography Dataset – digital database of surface waters used to make GIS maps. Used in the Integrated Report to geospatially display assessment units and aquatic inventory.
Nonpriority Pollutant:	Pollutants not on the priority pollutant list. Examples of those pollutants are ammonia, nutrients, iron, dissolved oxygen, pH and temperature.
ORSANCO:	Ohio River Valley Water Sanitation Commission – interstate commission authorized by congress in 1948 to control and abate pollution in the Ohio River Valley. The commission comprises the six Ohio River mainstem states and tributary states of New York and Virginia.
OSRW:	Outstanding State Resource Water – water bodies and segments afforded the designated use of OSRW based on support of federal threatened, endangered

species or water quality and biological qualities or unique features as provided in water quality standards.

PCR:	Primary Contact Recreation – recreation where full body contact with the water is expected.
Pollutant:	Examples of pollutant are: a solid waste; dredged spoil; sewage; chemical wastes; radioactive materials; temperature; industrial; municipal; and agricultural waste discharged into water Clean Water Act (CWA) (Section 502[6]).
Pollution:	The definition of pollution under the CWA (Section 502[19]): <i>The man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water.</i>
Priority Pollutant:	List of 126 (currently) pollutants that are organic compounds or that are toxic pollutants (e.g., metals) defined in Section 307 of the Clean Water Act. See Appendix D for the toxic parameters.
QAPP:	Quality Assurance Project Plan – the planning, procedures, quality assurance and control and project evaluation documentation.
RA:	Relative Abundance – numbers of a particular type of organism as a percentage of the total number of organisms.
SCR:	Secondary Contact Recreation – recreation where partial body contact with the water, excluding contact with the head, is expected.
SOP:	Standard Operating Procedure – document whereby the methods of particular processes are described and expected to be routinely followed.
STORET:	Acronym stands for STOrage and RETrieval, this is an EPA Data Warehouse
SU:	Standard Unit – a common unit of measurement, e.g., US customary units.
TDS:	Total Dissolved Solids – all inorganic and organic substance suspended in a liquid. Examples of TDS are calcium, magnesium, potassium, chloride and phosphates.
TMDL:	Total Maximum Daily Load – calculation of the amount “load” of a pollutant that a stream can assimilate daily without exceeding a certain criterion.
TKN:	Total Kjeldahl-nitrogen – measure of organic nitrogen and ammonia in water.
TNI:	Total Number of Individuals – a metric based on numbers of individuals, e.g., percentage of worms (Oligochaeta).
TP:	Total Phosphorus – all forms of phosphorus in a sample (orthophosphate, organic phosphate and condensed phosphates).
TSI:	Trophic State Index – the biological condition of a water body, defined by biomass, often algal biomass.

TSS:	Total Suspended Solids – all suspended solids, determined by weight of solid residue.
TVA:	Tennessee Valley Authority – manage one dam project in the Commonwealth.
USACE:	United States Army Corps of Engineers – manage 18 dam projects (15 entirely intrastate) in the Commonwealth.
USGS:	United States Geological Survey – federal research and resource monitoring agency.
UT:	Unnamed Tributary – tributary that has no official name according to GNIS.
WAH:	Warm Water Aquatic Habitat – surface water and habitat capable of supporting indigenous warmwater aquatic life.
WQS:	Water Quality Standards – define the objectives and goals of a water body by setting designated uses and criteria to protect the uses and antidegradation policy to protect existing uses and high quality waters.

Table of Contents

Chapter 3 Data requirements and assessment of designated uses for section 305(b) reporting	5
3.1 Data sources	6
3.2 Data sufficiency, credibility and quality.....	7
3.3 General Assessment element and aquatic life use assessment	8
3.3.1 Assessment elements and procedures	12
3.3.2 Substantial and reliable data: required minimum level of information and assessment.....	13
3.4 Assessment of primary contact recreation use	23
3.5 Assessment of secondary contact recreation use	25
3.6 Assessment for fish consumption	26
3.7 Domestic water supply use	27
3.8 Threatened use assessment category.....	28
3.9 Determining extent of coverage for use assessment	28
Literature Cited	31
Appendix B Level of information and water body system codes	32
Appendix D Causes (pollutants, with toxic parameters identified) and sources with ADB codes	37

Chapter 3.Data Requirements and Assessment of Designated Uses for Section 305(b) Reporting

This chapter addresses the consideration of data sources, a necessary level of data quality and rigor, data sufficiency and the data types applicable for the various DUs (designated use) assessed. Table 3-1 provides a synoptic view of the DU and the core indicators that are used to determine use support. These topics and procedures lead to application of WQS to monitored data for DU assessment.

3.1 Data Sources

The DOW monitors and collects the majority of data used to develop the 305(b) and 303(d) lists. In addition to the overview of water resource monitoring programs provided in Section 1.3, the DOW accepts data from a number of local, university, state and federal partners. The following are external sources of data, with the particular BMU of focus for

Table 3-1. Designated uses of Kentucky waters and the indicators used to assess designated use support.

Use	Aquatic Life	Primary or Secondary Contact Recreation	Fish Consumption ^a	Drinking Water ^b
Core Indicators	<p><i>Stream:</i> 1-2 biological communities: macroinvertebrates, and fishes^c Dissolved oxygen Temperature pH Specific conductivity/TDS Chemical Parameters (i.e., priority and nonpriority) Sedimentation</p> <p><i>Lake/Reservoir:</i> Dissolved oxygen Temperature pH Specific conductivity/TDS Parameters (nonpriority) Fish kills</p>	<p><i>Stream:</i> Pathogen indicators: fecal coliform; <i>E. coli</i> pH</p> <p><i>Lakes/Reservoir:</i> Pathogen indicators: fecal coliform or <i>E. coli</i> pH</p>	<p>Methylmercury Mercury PCBs Phenol</p>	<p>Inorganic chemicals Organic chemicals Pathogen indicators: fecal coliform; <i>E. coli</i></p>
Supplemental Indicators	<p><i>Streams:</i> Diatom Flow</p> <p><i>Lake/Reservoir:</i> Trophic State Index (TSI) Secchi depth Nuisance macrophytes Nuisance macroscopic algal growth Nuisance algal blooms</p>	<p>Nuisance macrophytes Nuisance macroscopic algal growth</p> <p>Nuisance algal blooms Suspended sediment (TSS) Odor Human toxic or behavioral response Debris Unnatural oil slick</p>	<p>Other chemicals of concern found in</p> <p>water quality standards</p>	<p>Odor Taste</p> <p>Treatment problems caused by poor water quality</p>

^aImplied designated use per 401 KAR 10:031 Sections 2 and 6.

^bAll core indicators are based on "at the tap" Consumer Confidence Report received from the domestic water supplier.

^cBiological communities are utilized in headwater and wadeable streams; assessments of boatable streams most often rely on chemical indicators only.

assessment driving the likelihood of a given local partner providing data. Other data sources are considered as they become available. To be used in listing decisions, volunteer data must meet the minimum requirements that any data source does. This data source is typically used for screening purposes.

- Eastern Kentucky University
- Kentucky Department for Fish & Wildlife Resources
- Kentucky Department for Natural Resources
- Kentucky Geological Survey
- Kentucky State Nature Preserves Commission
- Lexington-Fayette Urban County Government
- Louisville Metropolitan Sewer District
- Morehead State University
- Murray State University
- Northern Kentucky Sanitation District #1
- Ohio River Valley Sanitation Commission (ORSANCO)
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- U.S. Fish & Wildlife Service
- U.S. Forest Service
- U.S. Geological Survey
- University of Kentucky
- University of Louisville
- Western Kentucky University

3.2 Data Sufficiency, Credibility and Quality

Data quality is of paramount importance for making 305(b) and 303(d) listing decisions. This is due to the fact that an incorrect data assessment may result in a listing error of a water body or segment. Should a water body not be listed as not supporting when that is the case, there are consequences to that decision just as there are when assessing a water body as not supporting its uses when it is. In the case of incorrectly assessing a non-supporting DU as supporting, this action may lead to potential human health risks and ecological impairment that go unaddressed, or be delayed. Likewise, incorrectly assessing a supporting DU may result in increased costs to regulated entities, communities and individual landowners.

The DOW's data are collected under Division-approved SOPs (<http://water.ky.gov/Pages/SurfaceWaterSOP.aspx>) applicable to the water quality parameters and biological communities per test or study. Quality assurance project plans (QAPPS) are developed defining the minimum data quality and sufficiency. Data from sources outside of the DOW must be collected under the DOW's SOPs or a particular agency's SOPs that at least meet the minimum quality assurance and control requirements to the applicable DOW SOPs. Volunteer data may be used by the DOW for assessment purposes, but those data must be collected under SOP that is at least equivalent to the

applicable DOW SOP and a DOW-approved QAPP. Volunteer data not meeting quality objectives may be used for screening purposes.

Because of the complexity of making DU assessment determinations, a minimum level of rigor for data quality is necessary to provide reasonable assurance that the correct assessment decision has been reached. Figure 3.2-1 illustrates data sources, the assembly of data types by DU applicability and a decision point to assure data are of sufficient rigor to make a 305(b) assessment. These steps help to ensure that scientifically valid and informed conclusions are reached and provide a level of rigor and consistent processes that provide for legal defense of the final results. As science advances and WQS (water quality standards) are updated, these changes can affect future assessments made on water bodies previously assessed under earlier water quality criteria. For example, conditions may change between the time of the assessment and the monitoring for development of a TMDL occurs; in such a circumstance the resource could now support the DU. If this occurs, just cause for delisting the 303(d)-listed water body can be presented to EPA during the IR submission.

Information is presented in Tables 1 – 3, Appendix B to help determine whether sufficient data exist to make an assessment. The data hierarchies (U.S. EPA 2002, 1997) should be followed when determining the sufficiency of data and the appropriateness of their use. The Level of Information considers factors such as spatial/temporal coverage, data types and technical components.

3.3 General Assessment Elements and Aquatic Life Use Assessment

Biological Information

Assessment of WAH or CAH is collectively termed aquatic life use. WQS provide criteria for the maintenance of the health and function of aquatic habitats. For a biosurvey investigation where only macroinvertebrates were collected, headwater streams are those that drain less than 5-mi²; however, the cutoff for headwater streams for fishes is less than 6-mi². The MBI calibration defined wadeable streams as those draining 5-mi² (6-mi² considering fishes) or more, up-to approximately 250-mi² in drainage area (for fish use of the KIBI in catchment areas in the extreme range of its recommended use [>200 to 300 mi²] must be done so with caution (DOW 2003).

Large non-wadeable streams, or those generally greater than 250-mi², are assessed under different procedures and presented in the next subsection (*Physical and Chemical Information*). Assessment decisions involving headwater and wadeable aquatic life use attainment are primarily made using biological data obtained from monitoring programs within the DOW and agencies that meet data rigor that is required of the DOW such as USFS, USACE, USGS or other environmental agencies. Collecting, and especially determining the taxonomy of biological communities, requires considerable applied training or academic background. Data analysis is then completed to assess whether the community composition represents a healthy environment. Also interpretation of additional information discerned from the functional structure of that community (i.e., the relationships between habitat disturbance gradient, pollutants and community composition and function) often provide insights by comparing the community present to the expected community for the

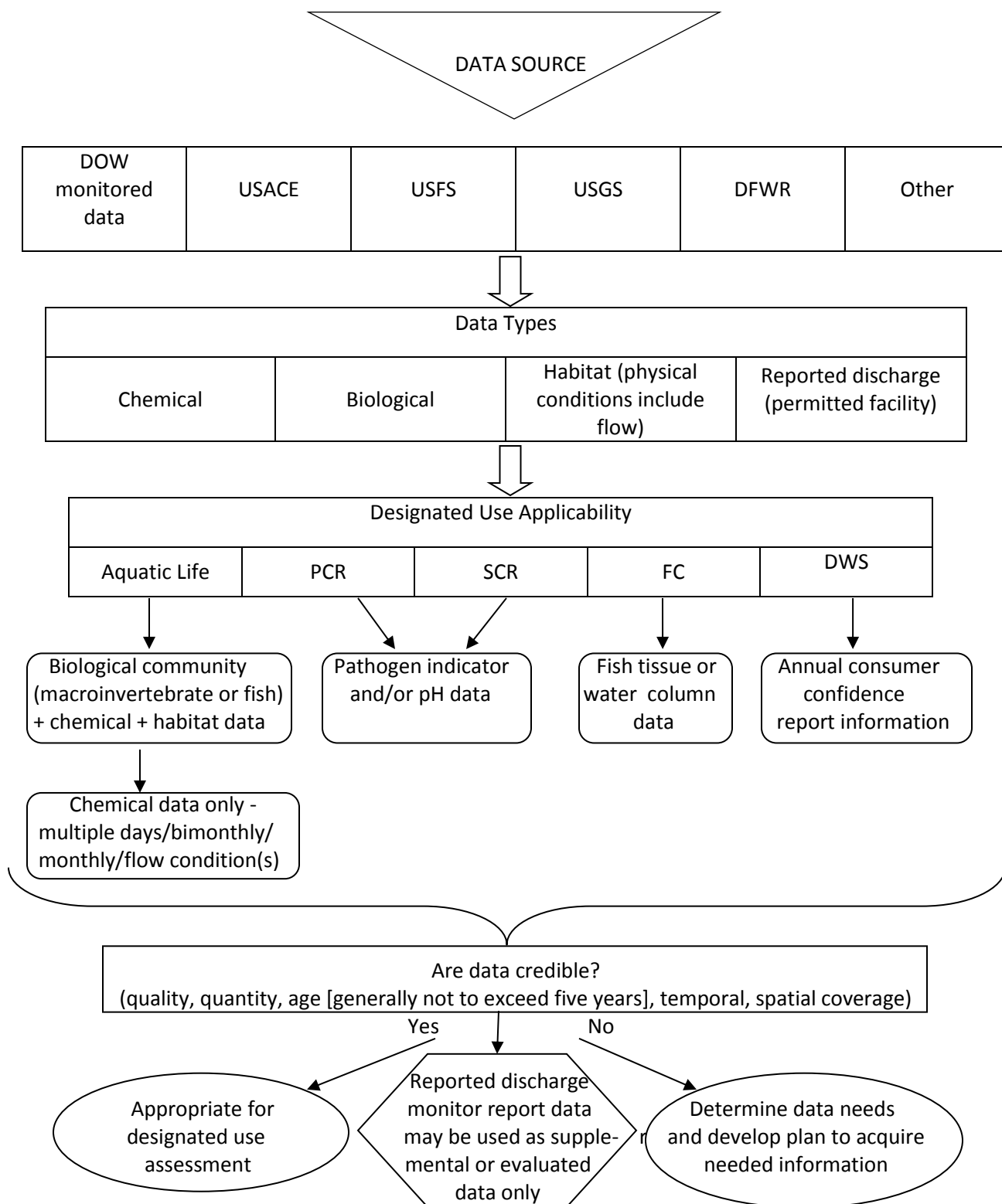


Figure 3.2-1. Sufficient and credible data determination procedures.

water body type under evaluation. There are numbers of reasons biological data are important in making level-of-support decisions for aquatic life use. Biological communities (indicators) integrate conditions of their environment and thus serve as good long-term indicators of the environment (physical, chemical and habitat) they live in. The indicators for biology-based assessments are outlined in Table 3.3-1. The two indices used to make bioassessment support determination are incorporated into WQS by reference in 401 KAR 10:030 (<http://www.lrc.ky.gov/kar/401/010/030.htm>). Level of use support is dependent on the indicator community(s) health and integrity as related directly to each multimetric index score narrative, along with chemical data (typically one grab sample collected at the time of each biosurvey) and supplemental habitat evaluation information.

Table 3.3-1. Biological criteria for assessment of cold- or warm water aquatic habitat (headwater and wadeable streams) use support.^a

<u>Indicator</u>	<u>Fully Supporting</u>	<u>Partial Support</u>	<u>Non-support</u>
Algae ^b	Diatom Bioassessment Index (DBI) Classification of excellent or good; biomass similar to reference/control.	DBI classification of fair; increased biomass (if nutrient enriched) of filamentous green algae.	DBI classification of poor; biomass very low (toxicity), or high (organic enrichment).
Macroinvertebrates	Macroinvertebrate Bioassessment Index (MBI) excellent or good, high EPT, sensitive species present.	MBI classification of fair, EPT lower than expected in relation to available habitat, reduction in relative abundance of sensitive taxa. Some alterations of functional groups (shift to mostly generalists) evident.	MBI classification of poor; EPT low, total number of individuals of tolerant taxa very high. Most functional groups missing from community.
Fishes	Kentucky Index of Biotic Integrity (KIBI) excellent or good; presence of uncommon, endangered or species of special concern.	KIBI fair.	KIBI poor, very poor, or no fish.

^aAcronyms used in this table: EPT= Ephemeroptera, Plecoptera, Trichoptera; RA= relative abundance; TNI- total number of individuals.

^bIndicator used in a supplemental capacity with fish or macroinvertebrate data; it is not used alone to make final use assessment decisions.

The DOW has enhanced its WQS through classifying uses of water bodies for aquatic life uses via tiering. Biological data can determine whether the CAH or WAH aquatic life use is met, and also determine the quality and system integrity of water bodies based on the results of biological community integrity. The biological multimetric indices, along with WQS developed to provide protection for qualities of aquatic resources in the Commonwealth, provide a strong program to not only assess level of use support, but to recognize and protect those water bodies and segments that exceed water quality conditions required to support the default uses. This is accomplished through categorization of Exceptional Water in the Antidegradation Policy adopted in WQS, 401 KAR 10:030 (<http://www.lrc.ky.gov/kar/401/010/030.htm>). Additionally, the aquatic life DU, OSRW (outstanding state resource water), have specific water quality criteria to enhance protection of those water bodies with high water quality and biological integrity (401 KAR 10:031).

Chemical Information

The physical and chemical criteria adopted by the DOW into WQS are found in 401 KAR 10:031 (<http://www.lrc.ky.gov/kar/TITLE401.HTM>). These criteria are used to assist in the identification of pollutants that when exceeded may negatively affect biological communities. In addition to the aquatic biocommunity indices, the core and supplemental chemical indicators are found in Table 3-1. These criteria may be used to assess aquatic life use alone as long as a sufficient number of samples are collected and the data are applied only to the spatial extent the monitoring rigor allows. Assessments have been made utilizing chemical data since the enactment of the CWA (Clean Water Act). In the early period, development of biological community quality and integrity indices had not occurred and the significant challenge of the time was controlling and abating chemical pollutant discharges to the aquatic environment. Currently, while biological multimetric indices are available for headwater and wadeable streams, the chemical data are the primary tool to assess water quality in large rivers, often called boatable streams, in addition to the manmade lakes and reservoirs. chemical criteria encompass two forms of chemical parameters, toxic and conventional pollutants. Examples of toxic pollutants (included in the Priority Pollutants) are mercury, methylmercury, benzene and DDT, a comprehensive list is available at: (<http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&SID=bd1b7f7d8f632c20259961d792e72b2e&rgn=div5&view=text&node=40:30.0.1.1.23&idno=40>); whereas examples of conventional pollutants are pH, dissolved oxygen (low concentration), conductivity and temperature. The supporting documentation for national recommended chemical criteria are found at <http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm> and applicable criteria to Kentucky's aquatic habitats are located in 401 KAR 10:031 (<http://www.lrc.ky.gov/kar/401/010/031.htm>).

When biological community data are collected, at a minimum, in-situ nonpriority pollutant data are obtained with a multiparameter meter using EPA-approved sensor measurement methodologies (temperature, DO (dissolved oxygen), percent DO saturation, pH, conductivity). In nearly all cases the DOW collects and has analyzed nutrients (nitrite + nitrate, ammonia, TKN, TP, total organic carbon) along with total suspended solids, chlorine, sulfate and alkalinity. Together, biological and chemical data types provide a robust dataset for assessment.

Nonpriority pollutants and a suite of many priority pollutants are collected for analyses at the DOW's ambient water quality stations. The priority pollutants include metals at those ambient stations. Water quality parameter data are collected with the necessary frequency to assess aquatic life use assessment for both conventional and toxic pollutants. Assessment methods for the applicable DU follow in Section 3.3.1.

3.3.1 Assessment Elements and Procedures

Assessment decisions are made with as many suitable data types as available; however, the majority of water bodies monitored and assessed for the first-time have only one dataset consisting of biological community information coupled with one-time chemical grab samples for nonpriority water quality parameters. It is biological community data that provide the substantial rigor and evidence needed to make level-of-support decisions using datasets with limited collection frequency. Adhering to Section 3.2 is critical in minimizing data error and thus reaching sound conclusions in decision making.

Once data are quality assured, the data must be categorized as either *monitored* or *evaluated*. The KDOW prefers to make DU support decisions that result in listing a water body or segment as requiring a TMDL using in-stream data. Additionally, data (i.e., chemical data and biological data [the biological data may still be useful given those data represent an integration of biological, chemical and physical habitat conditions]) older than five years should generally not be used to make a use support decision (U.S. EPA, 1997), unless it can be determined the data are still representative of current conditions. The greatest source of evaluated data is generated via the use of KPDES Discharge Monitoring Reports (DMR). The facilities where evaluated data are obtained through DMRs are small dischargers, those that discharge up to 50,000 gallons per day as these facilities consistently have permit exceedences as opposed to larger dischargers. The majority of discharges from those systems occur in small watersheds with a 7Q10 (the lowest 7-day average flow that occurs on average once every 10 years) low-flow of zero. The age of DMR datasets utilized are no more than five years old when making the provisional non-support decisions. The DOW created the 305(b) Assessment Category 5B to use with data of this type. The extrapolation of the DMR data to an assessment may trigger further KPDES inspection of the facilities. It would be inappropriate to use evaluated data to make a full support decision given the data are discharge results only.

Multimetric biological index results provide a tested, reliable foundation from which to make assessment decisions. Chemical data alone generally require more datasets to meet the minimum Level of Information (rigor) that include the frequency and temporal components necessary to detect exceedence of criteria and meet guidance for chemical-based use support decisions. Below are general examples of both data types that meet the level of rigor discussed:

- results from a biosurvey of one to two biological communities (fish or macroinvertebrates);
- a nonpriority pollutant standard that is exceeded once in conjunction with biological community score that has a narrative rating of fair, poor or very poor;
- a nonpriority pollutant parameters monitored at least during key periods (e.g., spring or summer) or sampling over a period of months; or

- priority pollutant, provided monitored data are sufficient to capture the needed frequency and magnitude.

The following section provides specific guidance necessary to assign Level of Information ratings with water body system type codes (Tables 1 – 3, Appendix B) to datasets when making concluding use-support assessment decisions.

3.3.2 Substantial and Reliable Data: Required Minimum Level of Information and Assessment

Once the data sufficiency and credibility are established, the monitored data rigor will meet an Information Level found in Tables 1 – 3 of Appendix B with a numeric interpretation of the narrative ranging from one to four, four being the greatest rigor. Each table contains three components for consideration when making the Level of Information decision for a dataset. These are: 1) technical components; 2) spatial/temporal coverage; and 3) data quality.

For illustrative purposes, most program data generated or obtained by the DOW for biological and habitat-based (Table 1 and 2, Appendix B) assessment is at Level of Information equaling three; however, some datasets reach a Level of Information of four (Tables 1 and 3, Appendix B). Generally, habitat evaluations generated by the DOW equal a Level of Information of three.

Biological monitoring programs in the DOW typically include one-time grab samples of chemical data, this results in a Level of Information of two (Table 3, Appendix B); whereas, ambient monitored data obtained at the Primary Stations have the rigor for a Level of Information equaling three (Table 1, Appendix B). For third-party data a QAPP is important in the determination of the appropriate Level of Information and may be required before the DOW will consider the data. A decision tree is provided for assessments both with and without biological community data (Figure 3.3.2-1).

Biology (Headwater and Wadeable Streams)

The qualities required to achieve one of the four levels of information when making aquatic life use assessment decisions is found in Table 1, Appendix B. Use of at least one community, either macroinvertebrates or fishes, is required for synoptic (general overview) and probabilistic monitoring bioassessment. For assessment based on one monitored biological community the DOW utilizes a professional biologist, and thus the Level of Information is three when one community is collected. Often a Level of Information of four is obtained as the DOW generally collects both fishes and macroinvertebrates. Table 3-1 provides an overview of the primary and secondary indicators that are used in aquatic life use support assessment.

Chemical

Along with biological community data, the DOW includes chemical data as a monitoring component in all headwater and wadeable stream programs for aquatic life use assessment. Streams that are considered boatable or non-wadable may routinely have only chemical data. The minimum dataset for headwater and wadeable streams normally collected include temperature, pH, DO, percent DO saturation and conductivity. In addition, the DOW often

collects a more comprehensive dataset that includes TP, nitrite + nitrate, TKN, ammonia, TSS, sulfate, chlorine, alkalinity and hardness.

When assessing DU support and nonpriority chemical data only comprise the dataset, the Level of Information should reach at least two. The minimum Level of Information needed for assessment of toxic pollutants must reach at least Level of Information three (Table 3, Appendix B).

Numeric Criteria

Nonpriority and Priority (i.e., the nontoxic parameters) pollutants are assessed by the DOW incorporating EPA guidance (U.S. EPA 2002, 1997). Water quality data are compared to criteria contained in Kentucky Water Quality Regulations (401 KAR 10:031). The segment fully supports WAH use when a pollutant criterion (e.g., dissolved oxygen, temperature and pH) is not met in 10 percent or less of the samples collected. Impaired, partially supporting, if any one criterion for these parameters is not met in greater than 10 – 25 percent of the samples (Table 3.3.2-1). A segment is impaired, not supporting, if any one criterion is not met in greater than 25 percent of the samples. Frequency of sample collection needed to evaluate the DU attainment. Appendix B, Table 3 offers guidance on decision making when considering assessment; the DOW requires a minimum of Level of Information of 2 be met in the absence of confirming biological data.

Priority (i.e., the Toxic parameters) pollutants are assessed by the DOW incorporating EPA guidance (U.S. EPA 2002, 1997). The DOW requires a minimum Level of Information of 3 be met to assess toxic parameters, per guidance (Appendix B, Table 3). For a list of the toxic (and nontoxic pollutants), please see Appendix D, Table 1. Generally, a minimum of quarterly samples over a three year period is needed to have sufficient frequency to pick up acute events.

Table 3.3.2-1. Nonpriority and priority pollutants (excluding toxic pollutants) criteria assessment.

<u>Level of Support</u>	<u>Fully Supporting</u>	<u>Impaired</u>	
		<u>Partially Supporting</u>	<u>Non-supporting</u>
<u>Percent of samples exceeded</u>	≤10 %	>10 – 25 %	>25 %

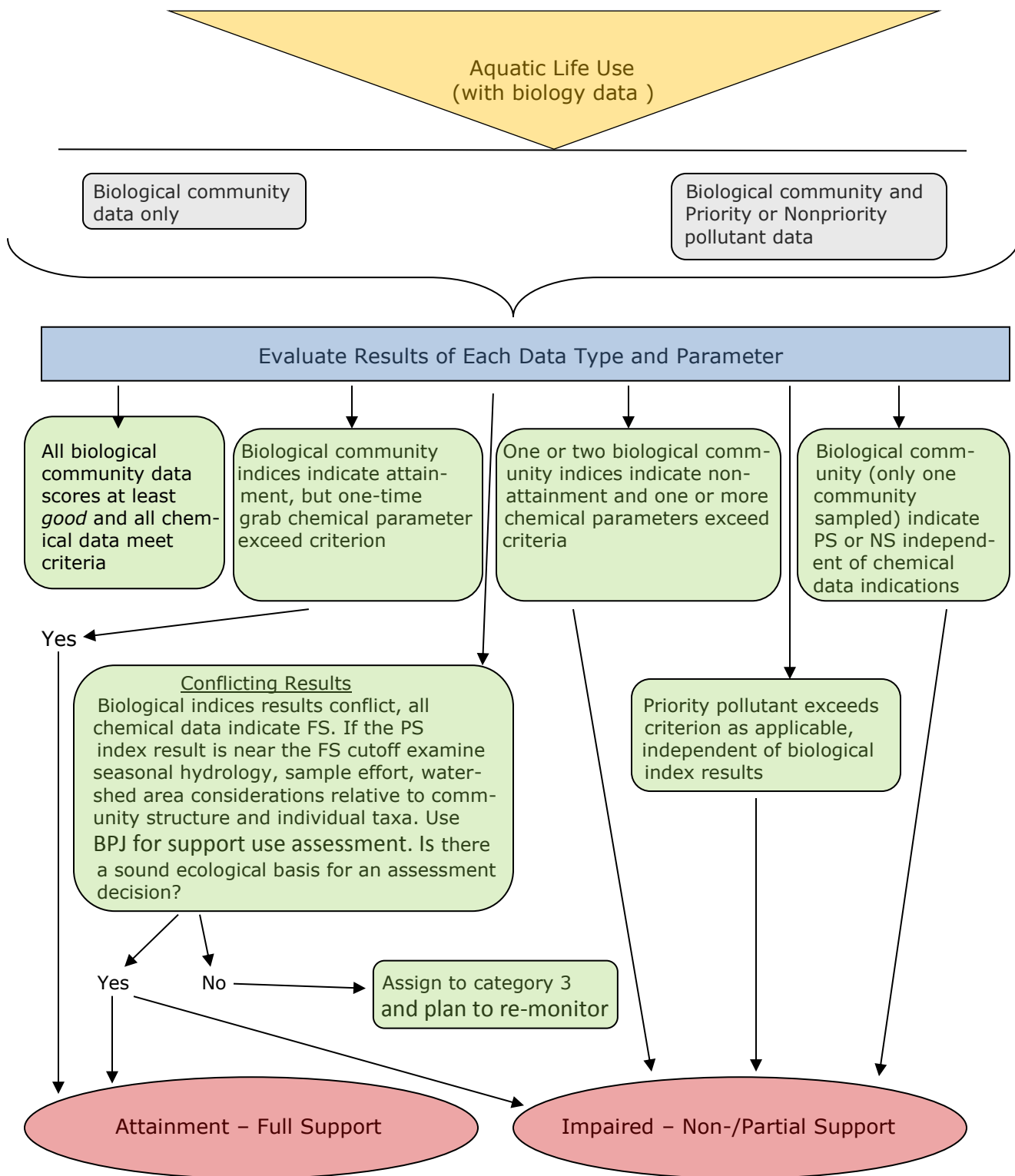


Figure 3.3.2-1. Decision tree for determination of assessment of the aquatic life designated use for monitored lotic waters.

Aquatic life is considered protected if acute and chronic criteria are not exceeded more than once every three years. A water body segment where an acute criterion is exceeded more than once within a three year period with at least quarterly sampling will be assessed not meeting the CAH or WAH DU (Appendix B, Table 3). It is impaired, partially supporting, if any one criterion is not met more than once but in less than 10 percent of the samples. The segment is impaired, not supporting, if criteria are exceeded in greater than 10 percent of the samples (Table 3.3.2-2).

Results are compared to chronic criteria using three years of bimonthly or more frequently collected data. Observations that equaled chronic criteria are not considered to exceed WQS. The segment is fully supporting CAH or WAH use if criteria are exceeded in no more than one sample over a three year period. Impaired, partially supporting if any criterion is not met in greater than one sample, but in 10 percent or less of samples. The segment is impaired, not supporting if any criterion is exceeded in greater than 10 percent of samples (Table 3.3.2-2). The assessment criteria were closely linked to the way state and federal water quality criteria were developed.

Table 3.3.2-2. Toxic pollutant criteria assessment.

	<u>Fully Supporting</u>	<u>Impaired</u>	
		<u>Partially Supporting</u>	<u>Non-supporting</u>
<u>Number of Exceedences</u>	No more than 1 in 3 years	More than 1 in 3 years, but less than 10 % of samples	More than 1 in 3 years and greater than 10 % of samples

While three years of quarterly or more frequent sample collections are preferred for toxic criteria assessment decisions, there are exceptions where less than three years of data may be considered. Assessment may occur in instances where multiple samples are collected and a criterion is exceeded as shown by data that provide overwhelming evidence that toxicity conditions exists by magnitude of concentration or frequency of excursions; thus, supporting a reliable impairment decision.

Narrative Criteria

While most water quality criteria in standards are numeric, there are certain standards based on narrative criteria. This includes nutrients, conductivity and minimum general criteria applicable to all surface water to protect the aesthetic and recreational qualities, and beneficial uses in general. Assessments are made in the following manner to protect against (narrative criteria function and are implemented as numeric criteria – both defined to be protective of the applicable DUs) an (cultural) eutrophication problem.

The narrative **nutrient criterion**, 401 KAR 10:031 Section 1:

Nutrients shall not be elevated in a surface water to a level that results in a eutrophication problem.

The guiding interpretation of the nutrient criterion is found in the definitions chapter of WQS, 401 KAR 10:001 Section 1(30):

"Eutrophication" means the enrichment of a surface water with nutrients nitrogen and phosphorus resulting in adverse effects on water chemistry and the indigenous aquatic community. Resulting adverse effects on water chemistry manifest by daily dissolved oxygen supersaturation followed by low dissolved oxygen concentrations and diurnal increase in pH. Resulting adverse effects on the indigenous aquatic community include:

- (a) Nuisance algae blooms;*
- (b) Proliferation of nuisance aquatic plants;*
- (c) Displacement of diverse fish or macroinvertebrate community by species tolerant of nutrient-enriched environments; or*
- (d) Fish kills brought on by severe, sudden episodes of plant nutrient enrichment.*

A vital part of monitoring is that field personnel document all conditions that may be associated either with or potential degradation of the water body when collecting physical, chemical or biological data. This information is useful when interpreting data for application of narrative criteria. Algae blooms that negatively affect the aquatic habitat include potentially toxic blue-green blooms and macroalgae growth that smother benthic or water column habitat. Proliferation of nuisance aquatic plants can have similar effects on the aquatic habitat, affecting spawning, displacing resident biota and the indigenous community structure. This proliferation of excessive algae and plant growth creates stressful environmental conditions. Some examples of excessive conditions that may result in nuisance conditions include the physical area of benthic algae coverage, sestonic algae creating obvious turbid conditions, floating algae, harmful algae blooms or macrophyte rafts.

Two important water quality response variables to nutrient stress (e.g., nitrogen and phosphorus) are DO and pH. These response variables are important data components when interpreting the nutrient criterion. DO concentrations that are unstable, having large swings involving supersaturation and concentrations falling below 4.0 mg/L in a 24-hour period, coupled with increased pH, are indications of excess nutrient concentrations, persistence of such conditions may lead to eutrophic problems.

Since both DO and pH are important in the determination of excess nutrient enrichment and to protect against an (cultural) eutrophication problem, knowing the general time of day the data are collected is an important factor when interpreting nutrient related responses. For the DOW, nearly all sampling occurs between late morning and early evening, which is the

time of greatest plant and algae use of carbon dioxide and the resultant release of oxygen. Excess nutrient enrichment conditions trigger a response in the concentration of diurnal (and diel) DO and a response in pH in the presence of excess nutrients during the growing season (April through October). From late morning into early evening those two response variables often will result in the percent DO saturation exceeding approximately 105 percent coincident with elevated pH greater than 8.5 SU; these are general conditions associated with plant nutrient enrichment. Consideration of the macroinvertebrate community structure for nutrient-tolerant taxa and the related functional structure, or excessive algae/plant growth are additional important elements of the aquatic conditions to take into account when assessing a DU as less than fully supporting.

Minimum General Criteria

The narrative **minimum general criteria**, 401 KAR 10:031 Section 2:

Minimum Criteria Applicable to All Surface Waters. (1) The following minimum water quality criteria shall be applicable to all surface waters including mixing zones, with the exception that toxicity to aquatic life in mixing zones shall be subject to the provisions of 401 KAR 10:029, Section 4. Surface waters shall not be aesthetically or otherwise degraded by substances that:

- (a) Settle to form objectionable deposits;*
- (b) Float as debris, scum, oil, or other matter to form a nuisance;*
- (c) Produce objectionable color, odor, taste, or turbidity;*
- (d) Injure, are chronically or acutely toxic to or produce adverse physiological or behavioral responses in humans, animals, fish, and other aquatic life;*
- (e) Produce undesirable aquatic life or result in the dominance of nuisance species;*
- (f)1. Cause fish flesh tainting.*

2. The concentration of phenol shall not exceed 300 µg/L as an instream value.

(2) The water quality criteria for the protection of human health related to fish consumption in Table 1 of Section 6 of this administrative regulation are applicable to all surface water at the edge of the assigned mixing zones except for those points where water is withdrawn for domestic water supply use.

(a) The criteria are established to protect human health from the consumption of fish tissue, and shall not be exceeded.

(b) For those substances associated with a cancer risk, an acceptable risk level of not more than one (1) additional cancer case in a population of 1,000,000 people, or 1×10^{-6} shall be utilized to establish the allowable concentration.

Criteria for each of those general pollutants in Section 2(1)(a – f)1 are promulgated to protect basic water quality and aesthetics from degradation and any acutely toxic substance for which numeric criteria do not exist. Each of these general criteria is applied based on

the DU that may be negatively affected. Those criteria in (a), (b), and turbidity of (c) are primarily associated with PCR and SCR uses. The criteria found in (d) and (e) are applicable to aquatic life use, PCR and SCR (f)1 and 2 to fish consumption. The taste and odor component is applicable to drinking water use.

These criteria are interpreted for assessment through methods and associated indicators particular to each applicable use. The criteria in (a), (b), and turbidity in (c) should be considered in the context of the ability to use a water body for swimming, paddle sports, general boating, and aesthetic enjoyment of the water body (i.e., PCR and SCR). The criteria in (a), (c) (color and turbidity), (d) and (e) may be interpreted through biological community composition and chemical information. Color is associated primarily with water quality that may affect aquatic community composition as in some dystrophic lakes; whereas, odor and taste are qualities most often associated with domestic water supply use. Potable water sources that are negatively affected by nutrients and eutrophic conditions often result in taste and odor problems, requiring costly filtration processes to produce a palatable product; turbidity is often a concern in nutrient-enriched water bodies so affected. Reoccurring seasonal conditions with these problems may lead to less than full support of the DWS use.

Protection against fish flesh tainting is provided through (Section 2(1)2 and 2(2)(a,b)). There is a numeric criterion for phenol in Section 2(1)(f)2 (CAS #108952) of 300 µg/L, while Section 2(2)(a,b) refers one to criteria located in Section 6, Table 1 of Chapter 10:031 for specific numeric human health criteria to protect the resource for fish consumption.

Aquatic Life

Warm water aquatic habitat, 401 KAR 10:031 Section 4 (narrative criteria and guidance found in this section, numeric application provided in section 3.3.2-1 *Numeric Criteria*, above).

Section 4. Aquatic Life. (1) Warm water aquatic habitat. The following parameters and associated criteria shall apply for the protection of productive warm water aquatic communities, fowl, animal wildlife, arboreous growth, agricultural, and industrial uses:

(c) Flow shall not be altered to a degree that will adversely affect the aquatic community; .

Flow is a critical element of the physical habitat; it determines the community composition that naturally inhabits lotic waters, as opposed to lentic-adapted aquatic communities. If flow is altered to some appreciable degree, chemical characteristics (change to the REDOX potential) including DO and temperature may be adversely affected. In addition, the physical regime that can alter the trophic dynamics of flowing waters. These conditions resulting from flow alterations, in turn, alter the indigenous biological community composition.

Water bodies and segments where the biological community index (particularly sensitive is the macroinvertebrate community) indicate less than a score of *good* may be impacted by altered flow, in addition to, or without, observed chemical impairments. Community composition relative to trophic structure is important in recognizing some flow regime

related impairments. For example, in headwater or wadeable streams (generally 1st – 5th [be aware some 5th order streams function as an autotrophic system] Strahler stream order) a shift from the generally shredder-collector-gatherer functional taxa to the scraper-filterer taxa that more generally represent $\geq 6^{\text{th}}$ (and some 5th) Strahler stream order systems. Dams or other structures that restrict or otherwise modify the natural flow regime often result in a shift of the natural functional feeding species to those associated with filtering suspended fine particulate organic material most common to autotrophic, less erosional systems.

Results where flow and physical habitat alone (i.e., pollution rather than a pollutant, keep in mind sediment is a pollutant) are the only recognized contributors to impairment, this case will result in the aquatic life use assessed and assigned to category 4C. In this scenario, if an additional cause is a pollutant (e.g., DO) that exceeds the criterion, the segment or water body is placed in category 5; included in the causes of impairment on the assessment sheet are the pollutions, for example *Other flow regime alterations* (refer to Table 2, Appendix D).

3. A successful demonstration concerning thermal discharge limits carried out pursuant to Section 316(a) of the Clean Water Act, 33 U.S.C. 1326, shall constitute compliance with the temperature requirements of this subsection. A successful demonstration assures the protection and propagation of a balanced indigenous population of shellfish, fish, and wildlife in or on the water into which the discharge is made;

(f) Total dissolved solids or specific conductance. Total dissolved solids or specific conductance shall not be changed to the extent that the indigenous aquatic community is adversely affected.

Conductivity is a surrogate measure of total dissolved solids (TDS) and is a common measure of pollutants that adversely affect the aquatic community at concentrations that exceed a natural range typical for conductivity/TDS of a water body. This pollutant affects many sensitive species of a healthy aquatic community potentially resulting in a depauperate assemblage of taxa; especially sensitive are the mayflies (Ephemeroptera). The eastern portion of Kentucky that encompasses ecoregions 68, 69 and 70 is typically naturally low in TDS and therefore conductivity. In these ecoregions, as conductivity exceeds 300 $\mu\text{S}/\text{cm}$ the MBI score will most often be below the *good* narrative rating indicating less than full support. Therefore, this is a breakpoint where conductivity should be listed as a pollutant when supported by a biological index score indicating the use is not supported. Other ecoregions outside eastern Kentucky where low conductivity may be naturally occurring are Ecoregions 73 and 74, known locally as the Jackson Purchase. For much of the remaining regions of the state conductivity is naturally higher due in large extent to the geology; thus, aquatic communities are adapted to those local (regional) conditions. Evaluation of the community structure is warranted when investigating possible listing of conductivity as a pollutant (cause), especially if the mayflies are absent or poorly represented in the macroinvertebrate community. In the ecoregions outside of ecoregions 68, 69, 70, 73 and 74 caution should be exercised when tying the impairment to conductivity.

(g) Total suspended solids. Total suspended solids shall not be changed to the extent that the indigenous aquatic community is adversely affected;

(h) Settleable solids. The addition of settleable solids that may alter the stream bottom so as to adversely affect productive aquatic communities shall be prohibited.

The standard *g* contain the criterion to protect against TSS (total suspended solids) (e.g., mineral-based such as silt and clay), but may include organic materials. The ambient network provides data on a watershed and ecoregional scale to determine long-term ambient conditions for TSS from which to compare the test water body. The following are DU that are likely to be adversely affected by excess total suspended solids: (a) recreation (swimming); (b) aquatic life (potentially impacts light penetration and sestonic and benthic communities); and (c) drinking water supply. Observation and/or measurement of total suspended solids are necessary to assess this criterion.

TSS are often associated with and more apparent through the manifestation of *h*, settleable solids. The criterion for TSS is most often represented in a water body by bottom sediments of sand, clay and silt. To assess this standard, one should have two important pieces of information, the habitat rating and narrative, and observe the biological community structure (especially the benthic macroinvertebrates) if available. For stream (lotic) habitats pay attention to the frequency and presence of riffles, runs and pools with respect to habitat and sedimentation (settleable solids). Streams where pools are no longer deep and are either filled or partially filled with sediment taking away this habitat function are obvious indicators of excess sediments in the system and the inability for the stream to manage a natural sediment load. Additionally, riffles are the single most important habitat to healthy headwater and wadeable streams. As such, they are targeted for sample collection of macroinvertebrates and fish populations. If the riffles are sedimented-in, show beginning stages of, or are embedded, obstructing the diversity of micro-niches (habitats) for lotic communities, then each of these conditions are indicative of the pollutant sediments/siltation. Again, relative expectations to the type of system (high- or low gradient streams), ambient condition of supporting streams, and the use of the reference conditions benchmark, should all be taken into consideration in data evaluation for assessment.

Outstanding State Resource Waters: Those that support federally threatened or endangered species are promulgated with the DU of OSRW and the listed species identified on the Special Waters webpage (<http://eppcapp.ky.gov/spwaters/>). The loss or measured (e. g. using semi-quantitative transect methods) decline of one of these populations constitutes an impairment of use. Since most data obtained are USFWS contracted studies and typically not quantitative, statistical analysis is not typically an option. Documented mortality (e.g., mussel die-off [fresh] observed and indicated by condition of empty shells) of individuals of the listed species that indicate an important population reduction, or absence, constitutes impairment. Additionally, to protect the federally listed population, the regulation states that existing habitat and water quality shall be maintained; therefore, water quality and habitat quality that were present at the time the water body was accepted for inclusion as an OSRW should be compared with future datasets to assure there is no decline. A measured important decline indicates impairment of the DU. Waters where previously unknown or newly listed populations of federally threatened or endangered

species inhabit are automatically included in each triennial review of WQS. Prior to actually promulgation of a water body or segment as an OSRW, the DOW typically extends the protection afforded the OSRW DU per 401 KAR 10:031 Section 8 once a listed population is identified in a water body.

Those OSRW that are listed under the permissible conditions in 401 KAR 10:031 Section 8(1) 1 and 2 are afforded the protection of sections 1 – 6 of 401 KAR 10:031 and 401 KAR 10:031(2)(a), at a minimum. Only one OSRW is promulgated (as of 2015) due to these provisions, Jessamine Creek, Jessamine County. Any applicable WAH or CAH criterion that exceeds the standard results in impaired listing for both WAH and OSRW.

OSRW that qualify via provisions in 401 KAR 10:031 Section 8(2)(b) that are listed as Exceptional Waters in 401 KAR 10:031, Section 1(2) shall have at a minimum DO maintained at 6.0 mg/L as a 24-hour average and instantaneous DO maintained at 5.0 mg/L. The non-attainment of the DO criterion constitutes impairment of the OSRW DU. Any criteria applicable to WAH or CAH that exceed standards result in the impaired listing of both WAH or CAH and OSRW.

Habitat

Physical habitat is evaluated using qualitative and semi-quantitative measurements of both in-stream and riparian vegetation zone characteristics. This includes the extent and integrity of the riparian vegetative zone, stream macrohabitat, hydrologic function and morphologic characteristics based on stream type. Notation and possible photographic documentation of surrounding land uses, and a description of any observable sources of potential pollutants, should be included. Since this set of information is used only ancillary to biological or chemical in-stream data, an acceptable minimum Level of Information for consideration is two (Table 2, Appendix B).

Assessment Dataset

Once the suite of data available for consideration is compiled and the data quality, credibility and sufficiency are determined, the DOW makes the final assessment decision. Figure 3.3.2-1 illustrates the amalgamation of potential datasets to reach final use support assessment decision for aquatic life use. Boatable (non-wadeable) streams will normally only have chemical data, but the dataset will typically be multiyear with a collection frequency of monthly and bimonthly and contain a suite of both conventional and toxic pollutants.

Lakes and Reservoirs

Lakes and reservoirs are assessed for aquatic life use by measuring several chemical indicators, in conjunction with confirmed reported or observed fish kills or nuisance algae blooms. Those confirmed observed or reported conditions must be tied to general water quality conditions rather than a brief episodic (up to several days) event. Harmful algal blooms (HAB) are part of the nuisance algae blooms category. The DOW started monitoring for HAB in 2013 and has coordinated with the USACE, the state health department and other agencies as appropriate. Without EPA recommended safe drinking water MCLs in finished water for HAB-related toxins, the DOW currently considers the World Health Organization (WHO) threshold of 1 µg/L for microcystin as indication of safe levels in finished drinking water.

The lack of a community-based biological indicator is primarily due to the fact that these resources are most often manmade, thus supporting altered and unnatural biological communities such as benthic organisms that are often composed of tolerant species (e.g., Tubificidae, *Chironomus* spp., *Chaoborus* spp., *Glyptotendipes* spp.) that are capable of exploiting this often DO-stressed environment. Thus, the core and supplemental indicators shown in Table 3-1 are of utmost importance to assure water quality conditions are suitable for supporting sportfish and associated prey fishes. Healthy populations of these fishes are the primary management concern for aquatic life use in these habitats. With all downstream water bodies, the reservoir monitoring programs assists to ensure downstream (below dam) DUs are supported.

DO is a key indicator of the health of a lake or reservoir. Profiles of DO concentration are produced in every monitored lake or reservoir, along with percent DO saturation, pH and specific conductivity. Under seasonal sampling conditions, these water bodies are stratified from mid-spring and usually until the second-half of September. Those stratified water bodies supporting the use should always have a DO concentration at or above 4.0 mg/L throughout the epilimnion (region of the trophogenic zone) with gradually decreasing DO concentration in the metalimnion. In a stratified lake, the hypolimnion overlays the profundal zone – this region is a concentrated area of decomposition containing the tropholytic zone – where DO depletion is common with increased carbon dioxide (CO₂) production. The pH and conductivity may increase with depth in many reservoirs due to the increased organic matter associated with the profundal habitat; however, there may be lower pH in the profundal zone due to elevated CO₂ enhancing conditions favorable for carbonic acid production.

Trophic state in lakes and reservoirs is determined using modified Carlson TSI (trophic state index) for chlorophyll *a*. Based on the TSI, lakes and reservoirs are ranked numerically according to increasing trophic state, the numeric ranges correspond to oligotrophic, mesotrophic, eutrophic, and hyper-eutrophic states. The growing season (April through October) average TSI value is used to rank each lake. The current and historic TSI (especially if it has increased and crossed trophic states) are both taken into account when assessing these water bodies. Increased TSI does not necessarily equate to non-supporting conditions, but over time may be symptomatic of cultural nutrient enrichment. Areas of large lakes that exhibit trophic gradients or embayment differences may warrant individual analysis.

3.4 Assessment of Primary Contact Recreation Use

Primary contact recreation use and associated criteria are developed to protect swimmers and other recreationalists who plan to expose themselves to full body immersion. Both fecal coliforms and *E. coli* are indicators of the likelihood for the presence of pathogens in a water body. Although both indicators are in the DEP regulations, *E. coli* is the preferred indicator because it has a stronger association with pathogenic agents and therefore it is the bacterium indicator regularly collected and analyzed by DOW for PCR use support. Currently, the DOW will assess PCR based on fecal coliform data; however, this criterion is planned for sunset language during the 2015 triennial review of water quality standards.

The applicable criteria (401 KAR 10:031 Sections 2(1)(a – e) and 7(1)) in WQS apply to this DU from May 1 through October 31. Regulation 401 KAR 10:031 Section 2(1)(a – e) apply as noted in Section 3.3.2 “Narrative Criteria” above. The two numeric criteria applicable are bacteria (*E. coli*) and pH. Determination of use support based on bacteria follows:

Single Sample Maximum Criterion

- fully supported when the single sample maximum is not met in ≤ 20 percent of six monthly samples collected over the six month recreation period (if only five monthly samples could be collected, then if the criterion is not met in two or fewer of the five samples it is considered fully supported);
- partially supported if the criterion is not met in >20 to 33 percent of those samples collected over the six month recreation period; and
- not supported if the criterion was not met in >33 percent of those samples collected over the six month recreation period.

30-Day Geometric Mean Criterion

- fully supported when the geometric mean of five samples collected during a 30-day period during the six month recreation period do not exceed the 30-day criterion;
- partially supported when the geometric mean of five samples collected over a 30-day period during the six month recreation period exceed the criterion; and
- not supported when the geometric mean of two sets of five samples collected in differing 30-day periods exceed the criterion of the six month recreation period.

In addition, the water quality parameter pH applies to PCR use. The criterion for pH may range between 6.0 – 9.0 SU, but cannot vary more than 1.0 SU over a 24-hour period. Where applicable, the criterion is applied to any water body to determine use support as follows:

- fully supported when the criterion is exceeded once, but in <10 percent of the samples during the recreation season;
- partially supported when the criterion is exceeded in >10 to 25 percent of samples collected;
- not supported when the criterion is exceeded in >25 percent of samples during the recreation season.

The narrative minimum general criteria, 401 KAR 10:031 Section 2 applicable to PCR follows:

Minimum Criteria Applicable to All Surface Waters. (1) The following minimum water quality criteria shall be applicable to all surface waters including mixing zones, with the exception that toxicity to aquatic life in mixing zones shall be subject to the provisions of 401 KAR 10:029, Section 4. Surface waters shall not be aesthetically or otherwise degraded by substances that:

(a) Settle to form objectionable deposits;

(b) Float as debris, scum, oil, or other matter to form a nuisance;

(c) Produce objectionable color, odor, taste, or turbidity;

(d) Injure, are chronically or acutely toxic to or produce adverse physiological or behavioral responses in humans, animals, fish, and other aquatic life;

(e) Produce undesirable aquatic life or result in the dominance of nuisance species.

Any material such as sediment, silt, turbidity (cloudy water), excess trash (either submerged or floating), oil slicks (unnatural), or unpleasant odor, that form and have more than an ephemeral presence (i.e., has some persistence that is greater than two days) and precludes recreational activity associated with PCR (swimming/bathing) apply to this DU and may result in non-support. Section 2(1)(e) particularly applies to lakes and reservoirs (although uncommon to local streams it equally applies to those water body types if conditions warrant). Any lake or reservoir where swimming is not restricted (e.g., many DFWR managed water bodies prohibit swimming) that has rooted or floating aquatic plants or algae restricting reasonable access to open water for swimming may result in non-support of the PCR DU.

Regulation 401 KAR 10:031 Section 2(1)(d) has a human health component that if conditions are met results in non-support of this DU. An example of a condition applicable to the criterion is toxins produced at a level by blue-green algae (often considered a nuisance species) that may result in adverse human physiological or behavioral reactions.

3.5 Assessment of Secondary Contact Recreation Use

Secondary contact recreation use and associated criteria are in-place to protect the recreationalist when activity does not involve full body emersion (e.g., incidental contact or wading). Pathogen-indicating bacteria, fecal coliforms, and pH are the principle indicators established to determine SCR support.

The applicable criteria (401 KAR 10:031 Sections 2(1)(a – e) and 7(2)) in WQS apply to this DU year-round. Regulation 401 KAR 10:031 Section 2(1)(a – e) apply as noted in Section 3.3.2 “Narrative Criteria” above. The two numeric criteria applicable are fecal coliforms and pH. Determination of use support based on fecal coliforms follows:

Single Sample Maximum Criterion

- fully supporting when the criterion is exceeded in ≤ 20 percent;
- partially supporting if the criterion is exceeded in >20 to 33 percent of samples; and
- non-supporting if the criterion is exceeded in >33 percent of samples.

30-Day Geometric Mean Criterion

- fully supporting when the geometric mean of five samples collected during a 30-day period does not exceed the criterion;
- partially supporting when the geometric mean of five samples collected during a 30-day period exceed the criterion; and
- non-supporting when the geometric mean of two sets of five samples collected in differing 30-day periods exceed the criterion.

In addition, the water quality parameter pH applies to SCR use. The criterion for pH may range between 6.0 – 9.0 SU, but cannot vary more than 1.0 SU over a 24-hour period. The water body assessed for this water quality criterion follows:

- fully supporting when the criterion is exceeded once, but ≤ 10 percent of the samples during the recreation season;
- partially supporting when the criterion is exceeded in >10 to 25 percent of samples collected;
- non-supporting when the criterion is exceeded in >25 percent of samples.

The narrative minimum general criteria, 401 KAR 10:031 Section 2(1)(a – e) applicable to SCR follows:

Minimum Criteria Applicable to All Surface Waters. (1) The following minimum water quality criteria shall be applicable to all surface waters including mixing zones, with the exception that toxicity to aquatic life in mixing zones shall be subject to the provisions of 401 KAR 10:029, Section 4. Surface waters shall not be aesthetically or otherwise degraded by substances that:

(a) Settle to form objectionable deposits;

(b) Float as debris, scum, oil, or other matter to form a nuisance;

(c) Produce objectionable color, odor, taste, or turbidity;

(d) Injure, are chronically or acutely toxic to or produce adverse physiological or behavioral responses in humans, animals, fish, and other aquatic life;

(e) Produce undesirable aquatic life or result in the dominance of nuisance species.

Any form of material such as sediment, silt, turbidity (cloudy water), excess trash (either submerged or floating), oil slicks (unnatural), unpleasant odor, etc., that form and have more than an ephemeral presence (i.e., has some persistence that is greater than two days) that precludes recreational activity associated with SCR (e.g., paddlesports, boating, wading, fishing) apply to this DU and may result in non-support. Section 2(1)(e) listed above particularly applies to lakes and reservoirs (although uncommon to local streams it equally applies to those water body types if conditions warrant). Any lake or reservoir that has rooted or floating aquatic plants or algae restricting reasonable access or precludes a recreational activity such as fishing may result in non-support of the SCR DU.

Regulation 401 KAR 10:031 Section 2(1)(d) has a human health component that if met results in non-support of this DU. An example given in the previous section applies equally for SCR under conditions that may result in adverse human physiological or behavioral reactions.

3.6 Assessment of Fish Consumption

Fish consumption is not a DU per state regulation. However, there exists criteria in WQS for the protection of the population should they choose to catch or buy local fish flesh for consumption. The most common pollutants of concern are mercury, methylmercury and PCBs. Those core and supplemental indicator pollutants are identified in Table 3-1. Applicable criteria may be found in WQS 401 KAR 10:031 Sections 2 and 6.

In 2001 the EPA issued a national recommended criterion for methylmercury in fish tissue (greater than 0.3 mg/Kg) for the safe consumption of fish flesh. For purposes of assessment, the average methylmercury concentration of composite species samples is compared to the criterion for exceedence of 0.3 mg/Kg methylmercury. Determination of use support based on this pollutant follows:

- fully supporting when fish tissue residue is ≤ 0.3 mg/Kg;
- partially supporting when fish tissue residue is > 0.3 mg/Kg to 1.0 mg/Kg; and
- non-supporting when fish tissue residue is ≥ 1.1 mg/Kg.

Composite filet samples of fish species are collected per SOP (<http://water.ky.gov/Documents/QA/ProceduresforResectionofFishFilletsandHomogenizationofTissueSamples.pdf>), concentrating on trophic levels 3 (e.g., bluegill, longear sunfish, and crappie) and 4 (e.g., large- and smallmouth bass, walleye, sauger, muskie). Larger (older) individuals in a population are targeted for collection given they usually represent the greatest contamination of methylmercury as well as other bioaccumulatives. The right filet, skin-off, will be processed for individual tissue residue analysis and composite samples. Each composite sample of fish are represented by the same species and are of similar size so that the smallest individual is no less than 75 percent of the total length of the largest individual (USEPA 2000). Three composite samples each representing trophic levels 3 and 4 are ideally collected; each composite sample represented by 200 g of composite homogenate. Since composite samples represent an average tissue contamination and usually eliminate nondetect samples, these samples are generally preferred. A composite sample that exceeds the criterion results in a less than full support decision.

The Great Lakes Initiative (GLI) protocols for fish consumption advisories for PCBs are based on fish tissue residue concentrations, which are triggered at the following tissue residue levels, resulting in less than full support of this use. The concentrations at which various degrees of support follow:

- fully supported when tissue residue is ≤ 0.2 mg/Kg (this relates to no human restriction in consumption or ban per the GLI);
- partially supported when the greatest species tissue residue is ≥ 0.25 mg/Kg to 1.0 mg/Kg (relates to a restricted consumption recommendation per the GLI); and
- not supported when fish tissue residue is ≥ 1.1 mg/Kg (this corresponds to a no consumption recommendation per the GLI).

3.7 Domestic Water Supply Use

The MCLs in WQS applicable to this use are found in 401 KAR 10:031. While this DU applies to all water bodies in the Commonwealth, the use is only implemented (via criteria, 401 KAR 10:031) at the point of water withdrawal by a public treatment facility. Public water systems are defined as those systems that have at least 15 service connections or regularly serve an average of 25 or more individuals (40 CFR 141.2) (<http://www.gpo.gov/fdsys/pkg/CFR-2010-title40-vol22/pdf/CFR-2010-title40-vol22-sec141-2.pdf>). In addition, the Commonwealth regulates facilities that are known as “semi-public” water systems. These serve more than three residences, but are smaller than public water systems.

This use is primarily assessed through compliance with the MCLs in finished water (Table 3-1). A treatment facility’s finished product must meet all non-disinfectant by-product MCLs (because the DU is assessed for the source water quality) based on the annual average of the quarterly sample results. An exceedence or violation of an MCL reported in the CCR indicates less than full use support of the water body. The DOW considers four or five years for DU assessment. If available, the DOW will consider in-stream data; gradations of use support assessment are as follows:

- fully supported if all MCLs are met as reported in the Consumer Confidence Report (CCR) or if all criteria are not met in ≤10 percent of samples collected from the point of withdrawal;
- partially supported if one MCL exceeds the criterion in the CCR or in-stream data at point of withdrawal is exceeded in >10 – 25 percent of samples; and
- not supported if two or more MCLs exceed the criteria per the CCR or in-stream data at point of withdrawal is exceeded in >25 percent of samples.

3.8 Threatened Use Assessment Category

This category is used for water bodies that currently support the DU, but are not expected to in the future. This determination requires placing the water body into Category 5 (U.S. EPA 2005) and therefore on the 303(d) list requiring a TMDL, 40 CFR 130.7(b) (<http://www.gpo.gov/fdsys/pkg/CFR-2007-title40-vol21/pdf/CFR-2007-title40-vol21-sec130-7.pdf>). For the water body to be considered threatened, datasets must indicate a clearly declining aquatic community or water quality trend over time. Valid statistical methodology should be applied indicating the decline and show the projected trend will result in the water body not fully supporting the DU by the date of the next listing cycle (the listing cycle is every two years).

3.9 Determining Extent of Coverage for Use Assessment

In general, the more robust the dataset the greater the confidence will be when determining the extent of the assessment results. Determination of the extent of coverage of an assessment is variable and the following are some initial considerations:

- stream order or relative volume to area drained;
- data type, chemical only or biological and chemical;
- frequency of data collection;
- period of data record; and
- predominant land uses downstream, but especially upstream of the sample locations.

Ambient Water Quality – Aquatic Life, PCR and SCR

Stations monitored for chemical parameters only typically occur at the ambient network locations; however, some may have biological data. These stations are usually located in large watersheds, the mid-points and downstream lower drainage reaches of 8-digit HUCs. These stations are monitored for a robust set of parameters that are monitored frequently, monthly in the BMU-year and bimonthly during the four intervening years. Given the network is designed to provide data on a large scale, these assessment units typically are larger than streams monitored with a limited frequency. Assessment segments are determined based on downstream and upstream substantial tributaries. The substantial tributaries are those that discharge a volume deemed to contribute a quantity that alone has an influence on the water quality of the monitored stream. Another important consideration is large-scale habitat conditions, particularly areas of intense landuse practices that disturb substantial areas (e.g., cities, towns, resource extraction or agriculture).

Headwater and Wadeable Streams – Aquatic Life

Water bodies in this category are smaller watersheds, the largest approximating 250-mi² and most are smaller watersheds that typically are drained by streams that fall into 1st – 5th Strahler stream order (Strahler, 1952). Data obtained in the headwater and wadeable streams monitoring programs usually have biological community data and chemical data obtained from one-time sample events. Segments assessed with these datasets are necessarily relatively short. Biological data are typically sensitive to subtle changes in environmental conditions, particularly habitat integrity. Of particular consideration in headwater and wadeable streams is both in-stream habitat and riparian habitat corridor integrity. The smaller the watershed, typically the quicker the biological response to perturbations since these water bodies have smaller areas of macrohabitats and the exposure of the biological community to disturbance gradients occurs rather quickly. This is contrasted to relatively large wadeable streams commonly of 4th and 5th Strahler order with greater macrohabitat availability and greater flow that may buffer change in water quality and habitat integrity.

Because of this, a fully supporting or non-supporting headwater stream will necessarily be of a small assessment segment, but will likely be of significant length relative to watershed. Streams of all sizes should be canvassed via GIS to obtain the locations of any point source discharges (DOW GIS layers provide this type of information). DMR information should be reviewed if the data indicate less than full support and the determination is based on water quality chemistry data rather than primarily habitat perturbations. Most commonly, the assessment segment should begin and end at tributary mouths that are either draining a large watershed in relative area or contribute substantial flow relative to the receiving

stream being assessed. Also consider any tributaries that are assessed as less than full support and the landuses of tributaries in general, relative to the stream being assessed.

Fish Consumption

Segments monitored for support determination for fish consumption are defined in a similar method as those reaches assessed using only chemical or bacteria data. Some fish species are relatively far ranging, which is significant when defining segments if this is the only use being assessed. Also, with the plethora of sources – especially for mercury that may reach the aquatic environment via multiple pathways including atmospheric deposition – relatively long reaches are typically defined when making these assessments, whether supporting or not. Significant tributaries are often used to determine the upstream and downstream termini, with less consideration given to habitat. In boatable streams that have locks and dams, the intervening pool between each is usually considered an assessment unit.

Drinking Water

Given this use is typically assessed utilizing finished water data supplied by PWS through the CCR the assessed source water segments are usually conservative. The assessment segments are typically taken from the point of withdrawal and extended upstream one mile. A few exceptions to that rule occur when multiple uses are assessed (e.g., fish tissue, aquatic life) in the same general area of PWS withdrawal points. Those segments are usually longer in order to accommodate other assessed uses that will overlap the PWS withdrawal point. For reservoirs the assessment is applied to the water body. As stated above, this DU is implemented only at points of withdrawal.

Reservoirs and Lakes

Because these water bodies have considerable retention time relative to streams, water quality monitoring normally occurs at a single location (forebay) or at additional locations within major tributary arms (embayments) of large reservoirs. Data are normally collected to assess the aquatic life use and SCR, although infrequent bacteria samples may be collected; generally PCR is not assessed lacking sufficient frequency. Additionally, many reservoirs have *no swimming* posted by the DFWR who manage those reservoirs. The no swimming postings are not a result of impairment of the DU, but are a management and safety decision by the DFWR.

While normally the assessment unit is the reservoir or lake, under certain circumstance there could be reason to assess an embayment separately from the main lake if that embayment has water quality differing to the degree it warrants treatment as a separate assessment unit. Such conditions would likely only present itself in large, USACE or TVA type reservoirs.

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Appendix B

Level of Information and Water Body System Codes

Table 1. Hierarchy of bioassessment approaches for evaluation of aquatic life use attainment based on resident assemblages (U.S. EPA, 1997).

Level of Info^a	Technical Components	Spatial/Temporal Coverage	Data Quality^b	WBS Codes^c
1	Visual observation of biota; reference conditions not used; simple documentation	Limited monitoring; extrapolations from other sites	Unknown or low precision and sensitivity; professional biologist not required	310, 320, 350, 322
2	One assemblage (usually invertebrates); reference conditions pre-established by professional biologist; biotic index or narrative evaluation of historical records	Limited to a single sampling; limited sampling for site-specific studies	Low to moderate precision and sensitivity; professional biologist may provide oversight	310, 320, 322, 350
3	Single assemblage usually the norm; reference condition may be site-specific or composite of sites (e.g., regional); biotic index (interpretation may be supplemented by narrative evaluation of historical records)	Monitoring of targeted sites during a single season; may be limited sampling for site-specific studies; may include limited spatial coverage for watershed-level assessments	Moderate precision and sensitivity; professional biologist performs survey or provides training for sampling; professional biologist performs assessment	310, 315, 320, 321, 330, 331, 350
4	Generally two assemblages, but may be one if high data quality; regional (usually based on sites) reference conditions used; biotic index (single dimension or multimetric index)	Monitoring during 1-2 sampling seasons; broad coverage of sites for either site-specific or watershed assessments; conducive to regional assessments using targeted or probabilistic design	High precision and sensitivity; professional biologist performs survey and assessment	310, 315, 320, 321, 330, 331, 340, 350

NOTE: Table is based on use in lotic systems. With some modification, these approaches would apply to other water body types.

^a Level of information refers to rigor of bioassessment, where 1 = lowest and 4 = highest.

^b Refers to ability of the ecological endpoints to detect impairment or to differentiate along a gradient of environmental conditions.

^c WBS (Water body System) Assessment Type Codes from Table 1-1.

Table 2. Hierarchy of habitat assessment approaches for evaluation of aquatic life use attainment (U.S. EPA, 1997).

Level of Info^a	Technical Components	Spatial/Temporal Coverage	Data Quality^b	WBS Codes^c
1	Visual observation of habitat characteristics; no true assessment; documentation of readily discernable land use characteristics that might alter habitat quality; no reference conditions	Sporadic visits; sites are mostly from road crossings or other easy access	Unknown or low precision and sensitivity; professional scientist (biologist, hydrologist) not required	365
2	Visual observation of habitat characteristics and simple assessment; use of land use maps for characterizing watershed condition; reference condition pre-established by professional scientist	Limited to annual visits and non-specific to season; generally easy access; limited spatial coverage and/or site-specific studies	Low precision and sensitivity; professional biologist or hydrologist not involved or only correspondence	370
3	Visual-based habitat assessment using standard operating procedures (SOPs); may be supplemented with quantitative measurements of selected parameters; conducted with bioassessment; data on land use compiled and used to supplement assessment; reference condition used as a basis for assessment	Assessment during a single season usually the norm; spatial coverage may be limited or broad and commensurate; assessment may be regional or site specific	Moderate precision and sensitivity; professional biologist or hydrologist performs survey or provides oversight and training	375
4	Assessment of habitat based on quantitative measurements of instream parameters, channel morphology, and floodplain characteristics; conducted with bioassessment; data on land use compiled and used to supplement assessment; reference condition used as a basis for assessment	Assessment during 1-2 seasons; spatial coverage usually broad and commensurate with biological sampling; assessment may be regional or site-specific	High precision and sensitivity; professional biologist or hydrologist performs survey and assessment	380

NOTE: Table is based on use in lotic systems. With some modification, these approaches would apply to other water body types.

^a Level of information refers to rigor of bioassessment where 1 = lowest and 4 = highest.

^b Refers to ability of the habitat endpoints to detect impairment or to differentiate along a gradient of environmental conditions.

^c WBS (Water body System) Assessment Type Codes from Table 1, Appendix C.

Table 3. Hierarchy of physical/chemical data levels for evaluation of aquatic life use attainment (modified from U.S. EPA, 2002 and 1997).

Level of Info^a	Technical Components	Spatial/Temporal Coverage	Data Quality^c	WBS Codes^d
1	<p>Any <u>one</u> of the following:</p> <ul style="list-style-type: none"> Water quality monitoring using grab water sampling Water data extrapolated from an upstream or downstream station where homogeneous conditions are expected Monitoring date >5 years old without further validation Best professional judgment based on land use data, source locations 	<p>Low spatial and temporal coverage:</p> <ul style="list-style-type: none"> Quarterly or less frequent sampling with limited period of record (e.g., 1 day) Limited data during key periods or at high or low flows (critical hydrological regimes)^b Data are >5 years old and are not reflective of current conditions 	Unknown /Low	210, 220, 230, 240, 850, 150, 130
2	<p>Any one of the following:</p> <ul style="list-style-type: none"> Water quality monitoring using grab water sampling Rotating basin surveys involving multiple visits or automatic sampling Synthesis of existing or historic information on fish contamination levels Screening models based on loadings data (not calibrated or verified) 	<p>Moderate spatial and temporal coverage:</p> <ul style="list-style-type: none"> Bimonthly or quarterly sampling during key periods (e.g., spring/ summer months) Fish spawning seasons, including limited water quality data at high and low flows Short period of record over a period of days or multiple visits during a year or season Data are <5 years old and there is high certainty that conditions have not changed since sampling 	Low/ Moderate	210, 220, 222, 230, 240, 242, 260, 810, 180
3	<p>Any one of the following:</p> <ul style="list-style-type: none"> Composite or a series of grab water sampling used (diurnal coverage as appropriate) Rotating basin surveys involving multiple visits or automatic sampling Calibrated models (calibration data < 5 years old) 	<p>Broad spatial and temporal (long term, e.g., ≥ 3 years) coverage of site with sufficient frequency and coverage to capture acute events:</p> <ul style="list-style-type: none"> Typically, monthly sampling during key periods(e.g., spring/ summer months, fish spawning seasons), multiple samples at high and low flows Lengthy period of record (sampling over a period of months) Data are <5 years old and there is high degree of certainty that conditions have not changed since sampling 	Moderate /high	211, 222, 242, 250, 610
Level of Info^a	Technical Components	Spatial/Temporal Coverage	Data Quality^c	WBS Codes^d

4	<p>Follows defined sampling plan which includes the following elements:</p> <ul style="list-style-type: none"> • Description of how sample is representative of target population • Defined data quality objectives, including error rate, confidence interval, sample size 	<p>Broad spatial (several sites) and temporal (long-term, e.g., ≥ 3 years) coverage of site with sufficient frequency and coverage to capture acute events, chronic conditions, and all other potential P/C impacts</p> <ul style="list-style-type: none"> • Monthly sampling during key periods (e.g., spring/ summer months, fish spawning seasons) including multiple samples at high and low flows • Fish spawning seasons including multiple samples at high and low flows • Continuous monitoring 	High	231, 242, 250
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NOTE Physical refers to physical water parameters (e.g., temperature, pH, dissolved oxygen, turbidity, color, conductivity).

^a Level of information refers to rigor of physical/chemical sampling and analysis, where 1 = lowest and 4 = highest.

^b Even a short period of record can indicate a high confidence of *impairment* based on P/C data; 3 years of data are not required to demonstrate impairment. For example, a single visit to a stream with severe acid mine drainage impacts (high metals, low pH) can result in high confidence of non-support. However, long-term .

^c Refers to ability of the toxicity endpoints to detect impairment or to differentiate along a gradient of environmental conditions.

^d WBS (Water body System) Assessment Type Codes from Table 1, Appendix C.

Appendix D
Causes (Pollutants) and Sources
with ADB Codes

Table 1. Causes (pollutants) and assessment database codes used under Section 305(b) water quality assessment (modified from ADB).

<u>Cause (Pollutant)</u>	<u>Cause Code</u>
.alpha.-BHC	01
.alpha.-Endosulfan(Endosulfan 1)	02
.beta.-BHC	03
.beta.-Endosulfan (Endosulfan 2)	04
.delta.-BHC	05
1,1,1,2-Tetrachloroethane	06
1,1,1-Trichloroethane ¹	07
1,1,2,2-Tetrachloroethane ¹	08
1,1,2-Trichloroethane ¹	09
1,1-Dichloro-1,2,2-trifluoroethane	10
1,1-Dichloroethane ¹	11
1,2,3,4-Tetrachlorobenzene	12
1,2,4,5-Tetrachlorobenzene ¹	13
1,2,4-Trichlorobenzene ¹	14
1,2,4-Trimethylbenzene	15
1,2-Butylene oxide	16
1,2-Dibromo-3-chloropropane	17
1,2-Dibromo-3-chloropropane (DBCP)	18
1,2-Dichloroethane ¹	19
1,2-Dichloroethylene	20
1,2-Dichloropropane ¹	21
1,2-Diphenylhydrazine ¹	22
1,3-Butadiene	23
1,3-Dichloropropene	24
1,4-Dioxane	25
2,2'-Dichlorodiethyl ether	26
2,2'-Dichlorodiisopropyl ether	27
2,3,7,8-Tetrachlorodibenzofuran	28
2,3-Dichloropropene	29
2,4,5-TP (Silvex) ¹	30
2,4,5-Trichlorophenol ¹	31
2,4,6-Trichlorophenol	33
2,4-D ¹	34
2,4-Diaminotoluene	35
2,4-Dichlorophenol ¹	36
2,4-Dimethylphenol ¹	37
2,4-Dinitrophenol ¹	38
2,4-Dinitrotoluene ¹	39
2,5-Dichlorophenol	40
2,6-Dinitrotoluene	41
2-Acetylaminofluorene	42
2-Chloroethyl vinyl ether	43
2-Chloronaphthalene ¹	44
2-Chlorophenol ¹	45
2-Ethoxyethanol	46
2-Methoxyethanol	47
2-Methylnaphthalene	48
2-Methylpyridine	49
2-Nitrophenol	50

3,3'-Dichlorobenzidine ¹	51
3,3'-Dimethoxybenzidine	52
3,3'-Dimethylbenzidine	53
3,4-Dichlorophenol	54
3-Chlorophenol	55
4,4'-Isopropylidenediphenol	56
4,4'-Methylenebis	57
4,4-Dichloro-2-butene	58
4-Aminobiphenyl	59
4-Bromophenylphenyl ether	60
4-Chloro-3-methylphenol (3-methyl-4-chlorophenol)	61
4-Chlorophenol	62
4-Dimethylaminoazobenzene	63
4-Methylphenol	64
4-Nitrophenol	65
5-Nitro-o-toluidine	66
Acenaphthene	68
Acenaphthylene ¹	69
Acetaldehyde	70
Acetamide	71
Acetochlor	72
Acetonitrile ¹	73
Acrolein ¹	74
Acrylamide	75
Acrylonitrile	76
Alachlor	77
Aldicarb	78
Aldrin ¹	79
Alkalinity, Carbonate as CaCO ₃	80
Allyl alcohol	81
Allyl chloride	82
Alpha particles	83
Alum (aluminum sulfate)	86
Aluminum	87
Ambient bioassays – acute aquatic toxicity	88
Ambient bioassays – chronic aquatic toxicity	89
Amitrole	90
Ammonia (Un-ionized)	91
Amnesic shellfish poisoning (ASP) biotoxins	92
Aniline	93
Anthracene ¹	94
Antimony ¹	95
Arsenic ¹	96
Asbestos ¹	97
Atrazine	99
BOD, Biochemical oxygen demand	100
BOD, carbonaceous	101
BOD, nitrogenous	102
BOD, sediment load (Sediment Oxygen Demand)	103
Barium ¹	104
Benzal chloride	106
Benzene ¹	107
Benzidine ¹	108

Benzo(a)pyrene (PAHs) ¹	109
Benzo[a]anthracene ¹	110
Benzo[b]fluoranthene ¹	111
Benzo[g,h,i]perylene	112
Benzo[k]fluoranthene ¹	113
Benzoic Acid	114
Benzoyl chloride	115
Benzyl chloride	116
Beryllium ¹	117
Beta particles and photon emitters	118
Biphenyl	119
Bis(2-chloroethyl) ether ¹	N/A
Bis(2-chloroethoxy)methane	120
Bis(2-chloroisopropyl) ether ¹	N/A
Bis(2-chlormethyl) ether	N/A
Bis(2-ethylhexyl) phthalate ¹	N/A
Bis(2-chloro-1-methylethyl)	121
Bis(n-octyl) phthalate	122
Boron	123
Bromoform ¹	124
Butyl benzyl phthalate ¹	125
Butyraldehyde	126
Cadmium	127
Captan	128
Carbaryl	129
Carbofuran	130
Carbon Disulfide	131
Carbon tetrachloride ¹	132
Cesium	133
Chemical oxygen demand (COD)	134
Chloramben	135
Chloramines	136
Chlordane	137
Chloride	138
Chlorine	139
Chlorine dioxide (as ClO ₂)	140
Chloroacetic acid	141
Chlorobenzene (mono) ¹	142
Chlorobenzilate	143
Chlorodibromomethane ¹	144
Chlorodifluoromethane	145
Chloroethane	146
Chloroform ¹	147
Chloromethyl methyl ether	148
Chlorophenyl-4 phenyl ether	149
Chloroprene	151
Chlorothalonil	152
Chlorpyrifos	153
Chromium (total) ¹	154
Chromium, hexavalent	155
Chromium, trivalent	156
Chrysene (C1-C4) ¹	157
Ciguatera fish poisoning (CFP) biotoxins	158

Cobalt	159
Color ¹	160
Copper	163
Creosote	164
Cresol (mixed isomers)	165
Cryptosporidium	166
Cumene	167
Cyanide	168
Cyanide (as free cyanide)	169
Cyanobacteria hepatotoxic microcystins	170
Cyanobacteria hepatotoxic nodularins	171
Cyanobacteria neurotoxic anatoxins	172
Cyanobacteria neurotoxic saxitoxins	173
Cyclohexane	174
DDD ¹	175
DDE ¹	176
DDT	177
DEHP (di-sec-octyl phthalate)	178
Dacthal	179
Dalapon	180
Debris/Floatables/Trash	181
Demeton	182
Di(2-ethylhexyl) adipate	183
Diallate	184
Diaminotoluene (mixed isomers)	185
Diarrhetic shellfish poisoning (DSP) biotoxins	186
Diazinon	187
Dibenz[a,h]anthracene ¹	188
Dibenzofuran	189
Dibutyl phthalate ¹	190
Dichlorobenzene (mixed isomers)	191
Dichlorobromomethane ¹	192
Dichlorodifluoromethane	193
Dichloromethane	194
Dichlorotrifluoroethane	195
Dichlorvos	196
Dicofol	197
Dieldrin	198
Diethyl phthalate ¹	199
Dimethyl phthalate	200
Dinitro-o-cresol	201
Dinitrophenols ¹	N/A
Dinoseb	202
Dioxin (including 2,3,7,8-TCDD)	203
Diquat	204
Disulfoton	206
Diuron	207
Dyfonate (Fonofos or Fonophos)	208
EPTC	209
Endosulfan	210
Endosulfan sulfate ¹	211
Endothall	212
Endrin	213

Endrin aldehyde ¹	214
Enterococcus	215
Epichlorohydrin	216
<i>Escherichia coli</i> (<i>E. coli</i>)	217
Ethelyne dibromide.....	219
Ether, bis(chloromethyl)	220
Ethylbenzene ¹	221
Ethylene	222
Ethylene glycol	223
Ethylene oxide	224
Ethylene thiourea	225
Fluometuron	231
Fluoranthene ¹	232
Fluorene ¹	233
Fluoride ¹	234
Foam/Flocs/Scum/Oil Slicks.....	235
Formaldehyde.....	236
Formic acid.....	237
Furan compounds.....	238
<i>Giardia lamblia</i>	239
Glyphosate	240
Gold	241
Guthion.....	242
Heptachlor	244
Heptachlor epoxide.....	245
Hexachlorobenzene ¹	246
Hexachlorobutadiene ¹	247
Hexachlorocyclohexane	248
Hexachlorocyclohexane	249
Hexachlorocyclohexane-Technical ¹	N/A
Hexachlorocyclohexane (mixture)	250
Hexachlorocyclopentadiene ¹	251
Hexachloroethane ¹	252
Hexachlorophene	253
Hexamethylphosphoramide	254
Hydrazine.....	255
Hydrochloric acid.....	256
Hydrogen cyanide	257
Hydroquinone	258
Indeno[1,2,3-cd]pyrene ¹	259
Iron	260
Isobutyraldehyde	261
Isophorone ¹	262
Isopropanol	263
Isosafrole	264
Kepone	265
Lead	267
Lindane.....	268
Linuron	269
Malathion	271
Maleic anhydride	272
Manganese.....	273
Mercury	274

Methacrylonitrile	275
Methanol	276
Methoxychlor	277
Methyl Parathion	278
Methyl Tertiary-Butyl Ether (MTBE)	279
Methyl bromide ¹	280
Methyl chloride	281
Methyl ethyl ketone	282
Methyl hydrazine.....	283
Methyl iodide	284
Methyl isobutyl ketone	285
Methyl methacrylate	286
Methylene bromide.....	287
Methylene chloride (dichloride) ¹	N/A
Methylmercury.....	288
Mirex	289
Molinate.....	290
Molybdenum.....	291
N-Nitroso-N-ethylurea	292
N-Nitroso-N-methylurea.....	293
N-Nitrosodimethylamine ¹	294
N-Nitrosodibutylamine ¹	N/A
N-Nitrosodiethylamine ¹	N/A
N-Nitrosodiphenylamine.....	311
N-Nitrosodipropylamine ¹	296
N-Nitrosomorpholine.....	297
N-Nitrosopiperidine.....	298
N-Nitrosopyrrolidine ¹	N/A
Naphthalene	299
Neurotoxic shellfish poisoning (NSP) biotoxins	300
Nickel	301
Nitrate ¹	302
Nitrilotriacetic acid	303
Nitrobenzene ¹	304
Nitrodibutylamine,N	305
Nitrofen	306
Nitrogen, Nitrite	307
Ammonia (Total)	308
Nitroglycerin	309
Nitrosamines	310
Octachlorostyrene	314
Octochloronaphthalene	315
Odor threshold number	316
Oil and Grease	317
Oxadiazon	320
Oxamyl (Vydate)	321
Oxygen, Dissolved	322
PCB-1242.....	323
PCB-1248.....	324
PCB-1254.....	325
PCB-1260.....	326
Paraldehyde	327
Paralytic shellfish poisoning (PSP) biotoxins.....	328

Parathion	329
Pentachlorobenzene	332
Pentachloroethane.....	333
Pentachlorophenol (PCP)	334
Perchlorate.....	335
Phenanthrene	337
Phenol ¹	338
Phosphate	340
Phosphorus, Elemental	341
Photomirex.....	342
Phthalic anhydride	343
Picloram	345
Picric acid	346
Polybrominated Biphenyls	347
Polychlorinated biphenyls	348
Prometon (Prometone)	349
Pronamide.....	350
Propanil (DCPA mono- and di-acid degrad	351
Propionaldehyde	352
Propoxur	353
Propylene Glycol	354
Propylene oxide	355
Pyrene ¹	356
Pyridine	357
Quinoline	358
Quinone.....	359
Quintozene.....	360
RDX.....	361
Radium	362
Radium 226	363
Radium 228	364
Safrole	366
Salinity	367
Sediment bioassays -- chronic toxicity freshwater	369
Sediment bioassays for estuarine and marine water	370
Sedimentation/Siltation.....	371
Selenium	372
Silica	373
Silicate	374
Silver.....	375
Simazine	376
Sodium.....	377
Solids (suspended/bedload)	378
Specific conductance	379
<i>Streptococcus</i> , fecal	381
Strontium	382
Styrene	383
Styrene oxide	384
Sulfates	385
Sulfide-Hydrogen Sulfide	386
Temperature, water	388
Terbacil	389
Terbufos	390

Tetrachloroethylene ¹	391
Tetrachlorvinphos.....	392
Thallium ¹	393
Thiourea	394
Tin	395
Toluene ¹	396
Total benzofluoranthenes	397
Total coliform	398
Total dissolved solids	399
Fecal coliform	400
Total Kjeldahl Nitrogen (TKN)	401
Total Organic Carbon (TOC)	402
Total Suspended Solids (TSS)	403
Total Trihalomethane (TTHM)	404
Toxaphene	405
Tributyltin TBT (Tributylstanne)	406
Trichlorfon	407
Trichloroethylene ¹	408
Trichlorofluoromethane (CFC-11)	409
Triethylene Glycol Dichloride.....	410
Trifluralin	411
Turbidity	413
Uranium.....	414
Vanadium (fume or dust)	415
Vinyl acetate	416
Vinyl bromide	417
Vinyl chloride ¹	418
Vinylidene chloride	419
Viruses (enteric)	420
Xylenes (total) (mixed)	421
Zinc.....	423
Zineb.....	424
alpha-Naphthylamine	425
beta-Naphthylamine	426
cis-1,2-Dichloroethylene	427
m-Cresol	428
m-Dichlorobenzene	429
m-Dinitrobenzene	430
m-Xylene	431
n-Butyl alcohol	432
o-Cresol (2-Methylphenol)	433
o-Dichlorobenzene	434
o-Toluidine	435
o-Toluidine hydrochloride	436
o-Xylene	437
p-Dichlorobenzene ¹	438
p-Phenylenediamine	439
p-Xylene	440
pH.....	441
sec-Butyl alcohol.....	442
tert-Butyl alcohol	443
trans-1,2-Dichloroethylene ¹	444
Polycyclic Aromatic Hydrocarbons (PAHs) (Aquatic Ecosystems)	447

Nutrient/Eutrophication Biological Indicators	448
Organic Enrichment (Sewage) Biological Indicators	449
Trivalent arsenic (arsenic III)	451
Nitrogen, Nitrate	452
Chlorine, Residual (chlorine demand)	453
Acidity (cold titration)	454
Acidity, Hot (hot titration)	455
Nitrate/Nitrite (nitrite + nitrate as N)	456
2,3,7,8-Tetrachlorodibenzo-p-dioxin (only) ¹	457
Nitrogen (total)	458
Whole Effluent Toxicity (WET)	461
Phosphorus (total)	462
Impairment (cause) unknown ²	463
Single sample toxic exceedence	464
(Methyl-) Mercury in Fish Tissue ¹	467
Mercury in water column ¹	468
Fipronil	469
Gross Alpha	470
PCB in fish tissue ³	472
PCB in water column	473
Dissolved gas supersaturation	474
Sediment bioassays -- acute toxicity freshwater	475
Other	476
Petroleum hydrocarbons	480
Diesel Fuel	481
Gasoline.....	482
Kerosene.....	483
Fuel Oil No. 6	484
Fuel Oil No. 5	485
Fuel Oil No. 4	486
n-Nonylbenzene	487
Dodecylbenzene.....	488
Alkylbenzene	489
pH, low	490
pH, high	491
Cyclohexanamine, N-ethyl-1-phenyl-.....	494
Perfluorooctane sulfonate (PFOS)	496
Perfluorooctane sulfonate (PFOS) in fish tissue	497
Chlordane in fish tissue ¹	498
DDT in fish tissue	499
Sludge.....	502
Residues ⁴	506
cis-Chlordane	510
trans-Nonachlor	511
Total inorganic nitrogen as N	512
Total soluble inorganic nitrogen as N	513
Bis(2-chloroethyl) ether ¹	516
Bis(2-chloroisopropyl)ether ¹	517
Dichloropropenes	518
Visible Oil	519
Odor	520
Ethanol	521
Nonylphenol	522

Tritium	523
Aluminum, dissolved.....	524
Aluminum, total recoverable	525
Selenium, dissolved	526
Selenium, total recoverable	527
Mercury, dissolved	528
Mercury, total	529

¹Pollutant tied to human health criterion only in regulation, 401 KAR 10:031

²Should only be used as last option when impairment exists and no pollutant can be identified

--Pollution--

Definition of pollution under the CWA (Section 502[19]): *The man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water.*

The following is a list of measurements and categories considered pollution. There are ADB codes for these, but in and of themselves do not constitute a pollutant; therefore, they will not be included in a 303(d) listing, nor result in a TMDL.

Table 2. Pollution and assessment database codes used under Section 305(b) water quality assessment (modified from ADB).

<u>Pollution</u>	<u>ADB Code</u>
Abnormal fish histology (lesions)	67
Alteration in stream-side or littoral vegetative covers	84
Alterations in wetland habitats	85
Atlantic sea lamprey, <i>Petromyzon marinus</i>	98
Benthic macroinvertebrate bioassessments	105
Chlorophyll-a	150
Combination benthic/fishes bioassessments	161
Combined biota/habitat bioassessments	162
Dissolved oxygen saturation	205
Eurasian Water Milfoil, <i>Myriophyllum spicatum</i>	206
Estuarine bioassessments.....	218
Eurasian water milfoil, <i>Myriophyllum spicatum</i>	226
Excess algal growth	227
Fish passage barrier	228
Fish kills.....	229
Fishes bioassessments	230
Habitat assessment (streams)	243
Lake bioassessments	266
Low flow alterations	270
Non-native fish, shellfish, or zooplankton	313
Other anthropogenic substrate alterations	318
Other flow regime alterations	319
Periphyton (aufwuchs) indicator bioassessments	336
Secchi disk transparency	368
Suspended algae	387
Trophic state index	412
Zebra mussel, <i>Dreissena polymorph</i>	422

Abnormal fish deformities, erosions, lesions, tumors (DELTS)	445
Habitat assessment (lakes)	446
High flow regime	450
Aquatic plants - native	460
Fish advisory - no restriction.....	465
Sediment screening value (exceedence)	466
Bottom deposits.....	471
Non-native aquatic plants.....	312
Partial pressure of dissolved gases	330
Particle distribution (embeddedness)	331
Physical substrate habitat alterations.....	344
Taste and Odor	459
Bacterial slimes.....	477
Aquatic plants (macrophytes)	478
Aquatic algae	479
Aquatic macroinvertebrate bioassessments	492
Aquatic plant bioassessments	493
Lack of a coldwater assemblage	495
Changes in stream depth and velocity patterns	500
Loss of in-stream cover	501
Natural conditions (flow or habitat)	503
Direct habitat alterations	504
Invasive aquatic algae	505
Light attenuation coefficient	507
Electrical conductivity (EC)	508
Sodium Adsorption Ratio (SAR)	509
Algal growth potential (AGP)	514
Plankton count.....	515

Table 3. Probable sources of impairment to Kentucky rivers and streams.

<u>Source Group</u>	<u>Source ID</u>	<u>Source</u>
<u>Agriculture</u>		
	4	Animal feeding operations (NPS)
	5	Animal shows and racetracks
	6	Aquaculture (not permitted)
	7	Aquaculture (permitted)
	11	Auction barns
	30	Crop production with subsurface drainage
	31	Dairies (outside milk parlor areas)
	46	Grazing in riparian or shoreline zones
	73	Managed pasture grazing
	87	Non-irrigated crop production
	100	Permitted runoff from Confined Animal Feeding Operations (CAFOs)
	108	Rangeland grazing
	123	Specialty crop production
	143	Livestock (grazing or feeding operations)
	144	Crop production (crop land or dry land)
	156	Agriculture
	161	Pesticide application
	173	Manure runoff
	174	Unrestricted cattle access
	179	Lake fertilization
<u>Non-Point Sources</u>		
	8	Atmospheric deposition - acidity
	9	Atmospheric deposition - nitrogen
	10	Atmospheric deposition - toxics
	16	Cercla NPL (superfund) sites
	24	Commercial districts (industrial parks)
	26	Commercial districts (shopping/office Complexes)
	67	Land application of wastewater (non-agricultural)
	68	Land application of wastewater biosolids (non-agricultural)
	84	Municipal (urbanized high density area)
	92	On-site treatment systems (septic & similar decentralized systems)
	97	Other spill related impacts
	107	Post-development erosion and sedimentation
	111	Residential districts
	122	Site clearance (land development or redevelopment)
	130	Unpermitted discharge (domestic wastes)
	131	Unpermitted discharge (industrial/commercial Wastes)
	133	Wastes from pets
	134	Waterfowl
	136	Wildlife other than waterfowl
	141	Non-point source
	146	Sources outside state jurisdiction or borders
	153	Wet weather discharges (non-point source)
	161	Pesticide application
	162	Watershed runoff following forest fire
	169	Unspecified urban stormwater
	171	Unspecified land disturbance

	175	Contaminated groundwater
	177	Urban runoff/storm sewers
	181	Runoff from forest/grassland/parkland
	141	Non-point source
	185	Failing infrastructure (sanitary sewers)
<u>Habitat Impacts</u>		
	19	Channel erosion/incision from upstream hydromodifications
	20	Channelization (canalization)
	21	Clean sediments
	36	Drainage/filling/loss of wetlands
	38	Dredging (e.g., for navigation channels)
	42	Flow alterations from water diversions
	44	Freshettes or major flooding
	51	Historic bottom deposits (not sediment)
	52	Hydrostructure impacts on fish passage
	71	Littoral/shore area modifications (non-riverine)
	72	Loss of riparian habitat
	125	Streambank modifications/destablization
	132	Upstream impoundments (e.g., PI-566 NRCS structures)
	157	Habitat modification - other than hydromodification
	163	Low water crossing
	186	Shallow lake or reservoir basin
<u>Silviculture</u>		
	43	Forest roads (road construction and use)
	101	Permitted silvicultural activities
	118	Silviculture - large scale (industrial) unpermitted forestry
	119	Silviculture harvesting
	120	Silviculture plantation management
	121	Silviculture reforestation
	137	Woodlot site clearance (majority of KY forestland in private ownership)
	138	Woodlot site management (sm. private tree farms)
	158	Silviculture, fire suppression
	161	Pesticide application
	162	Watershed runoff following Forest Fire
	166	Silviculture activities
<u>Resource Extraction</u>		
	37	Dredge mining (e.g., coal removal from Big Sandy R. channel)
	2	Acid mine drainage
	22	Coal mining discharges (permitted)
	47	Hardrock Mining Discharges (Permitted)
	48	Heap-leach extraction mining
	56	Impacts from abandoned mine lands (inactive)
	82	Mine tailings
	83	Mountaintop mining
	93	Open-pit mining
	102	Petroleum/natural gas activities
	103	Petroleum/natural gas production activities (permitted)
	105	Placer mining
	114	Sand/gravel/rock mining or quarries

	126	Subsurface (hardrock) mining
	127	Surface mining
	159	Reclamation of inactive mining
	165	Coal mining
	172	Potash mining
	178	Coal mining (subsurface)
	184	Coal mining (surface/subsurface)
	186	Legacy coal extraction
<u>Municipal Point Sources</u>		
	23	Combined sewer overflows
	33	Discharges from biosolids (SLUDGE) storage, application or disposal
	34	Discharges from Municipal Separate Storm Sewer Systems (MS4)
	85	Municipal point source discharges
	86	Municipal point source impacts from Inadequate Industrial/Commercial Pretreatment
	86	Municipal point source impacts from inadequate industrial/commercial pretreatment
	99	Package plant or other permitted small flows discharges
	115	Sanitary sewer overflows (collection system failures)
	128	Total retention domestic sewage lagoons
	185	Failing treatment infrastructure associated with sanitary sewers (leaking collection system)
	135	Wet weather discharges (point source and combination of stormwater, SSO or CSO)
<u>Transportation</u>		
	3	Airports
	12	Ballast water releases
	15	Cargo loading/unloading
	25	Commercial ferries
	49	Highway/road/bridge runoff (non-construction related)
	50	Highways, roads, bridges, infrastructure (new construction)
	112	Salt storage sites
	124	Spills from trucks or trains
	170	Unspecified unpaved road or trail
<u>Industrial Sources</u>		
	61	Industrial land treatment
	62	Industrial point source discharge
	63	Industrial thermal discharges
	64	Industrial/commercial site stormwater discharge (permitted)
	122	Site Clearance (land development or redevelopment)
<u>Recreation Sources</u>		
	95	Other recreational pollution sources
	45	Golf courses
	60	Impacts from resort areas (winter and non-winter resorts)
	91	Off-road vehicles
	106	Pollutants from public bathing areas
	181	Runoff from forest/grassland/parkland

<u>Sediments</u>		
	28	Contaminated sediments
	65	Internal nutrient recycling
	148	Sediment re-suspension (clean sediment)
	149	Sediment re-suspension (contaminated sediment)
<u>Marina / Boating Sources</u>		
	74	Marina boat construction
	75	Marina boat maintenance
	76	Marina dredging operations
	77	Marina fueling operations
	78	Marina-related shoreline erosion
	79	Marina/boating pumpout releases
	80	Marina/boating sanitary on-vessel discharges
	94	Other Marina/Boating On-vessel Discharges
	117	Shipbuilding, repairs, drydocking
<u>Water Quantity or Withdrawal</u>		
	13	Baseflow depletion from groundwater withdrawals
	113	Saltwater intrusion from groundwater overdrafting
	152	Transfer of water from an outside watershed
<u>Permitted Sources (other)</u>		
	1	Above ground storage tank leaks (tank farms)
	8	Atmospheric deposition - acidity
	9	Atmospheric deposition - nitrogen
	10	Atmospheric deposition - toxics
	27	Construction stormwater discharge (permitted)
	69	Landfills
	70	Leaking underground storage tanks
	109	RCRA hazardous waste sites
	146	Sources outside state jurisdiction or borders
	153	Wet weather discharges (non-point source)
	175	Contaminated groundwater
<u>Inappropriate or Illegal Waste Disposal</u>		
	54	Illegal dumps or other inappropriate waste disposal
	55	Illicit connections/hook-ups to storm sewers
	116	Septage disposal
	130	Unpermitted discharge (domestic wastes)
	160	Inappropriate waste disposal
	167	Unspecified domestic waste (e.g., straight-pipes)
Preferred over 167	168	Sewage discharges in unsewered areas
<u>Other</u>		
	17	Changes in ordinary stratification and bottom water hypoxia/anoxia
	39	Drought-related impacts
	57	Impacts from geothermal development

	65	Internal nutrient recycling
	92	On-site treatment systems (septic & similar decentralized systems)
	140	Source unknown
	145	Natural conditions - water quality standards use attainability analyses needed
	147	Upstream source
	150	Forced drainage pumping
	151	Naturally occurring organic acids
	154	Upstream/downstream source
	155	Natural sources
	176	Rural (residential areas)
	180	Introduction of non-native organisms (accidental or intentional)
	187	Shallow lake/reservoir basin